ЗЕНИТНЫЕ РАКЕТНЫЕ КОМПЛЕКСЫ

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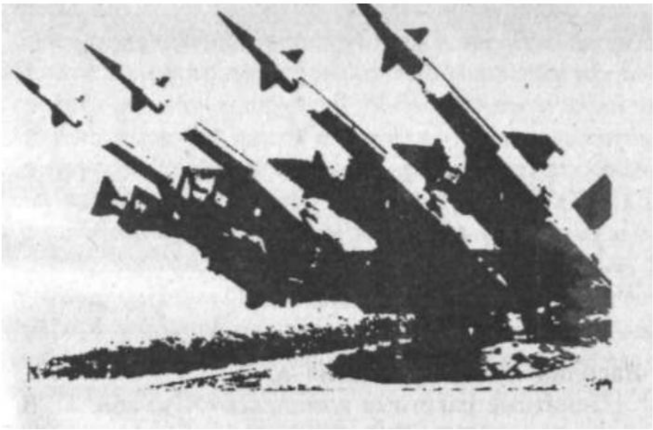
ANTI-AIRcraft MISSILE SYSTEMS



From the authors

The emergence of aviation and its use in military affairs entailed the creation of air defense systems. As the means of air attack developed, the means of defense against it became more and more advanced. A new impetus that required increasing the effectiveness of air defense systems was the emergence

nuclear weapons, when even one carrier aircraft is nuclear-
This weapon, having broken through the enemy's defenses, is capable of causing significant damage to him. As a result, the first S-25 Berkut and Nike-Ajax anti-aircraft missile systems, which have approximately the same characteristics, were developed and put into service in the USSR and the USA. Further development

air attack weapons and a change in views on their place and role in modern warfare required the development and adoption of new, more effective air defense systems.

The military conflicts of recent decades, and especially the wars in the Persian Gulf and Yugoslavia, have shown how much the role of manned and unmanned air attack weapons in combat operations has changed. They turned into the main striking force, while the second phase of the operation - the ground one - never came, since the objectives of the combat operations were achieved through the use of precision weapons from the air. In such conditions, the course and outcome of the war depends on the confrontation between air attack means and means of defense against them.

Until recently, information about air defense systems was inaccessible to a wide range of readers, as it was hidden under the heading of secrecy. And only recently, when the secrecy stamp was removed from many systems, separate publications began to appear devoted to the principles of operation and experience in the combat use of anti-aircraft missile systems. The authors of the book summarized the scattered material available in the domestic and foreign press and presented it to the reader in the form of separate articles devoted to the history of development, design and experience in the combat use of anti-aircraft missile systems. The book will be of interest not only to specialists in the field of air defense and electronic warfare, but also to lovers of military history and technology, since it contains a lot of information about military

technical and historical nature.

The book consists of four sections. The first reveals the basic principles of the construction and operation of anti-aircraft missile systems, which allows you to better understand the material subsequent sections, which are devoted to portable, sub-visible, towed and stationary systems. The book describes the most common types of anti-aircraft missile weapons, their modifications and development. Particular attention is paid to the experience of combat use in wars and military conflicts of recent times.

Basic abbreviations

AP - autopilot ARM -
automated workstation ACS - automated control system BR -
ballistic missile BSV - high and medium altitude warhead - warhead
VKP - air command post VKU - video
control device VRD - air jet engine GOS - homing
head RPV - remotely
piloted aircraft AWACS devices - long-range radar
detection liquid rocket engine - liquid rocket engine
ZA - anti-aircraft artillery ZAK - anti-aircraft artillery complex
SPTA - spare tools and devices ZPRK - anti-
aircraft missile and gun complex ZRV - anti-aircraft missile forces SAM - anti-aircraft
missile system ZRO - anti-aircraft missile defense ZSU - self-propelled
anti-aircraft missile system - anti-aircraft guided missile IA -
fighter aircraft KP - command post
KPS - command post of the KR system - cruise missile KRU -
command radio control line KSA - complex of aircraft
automation equipment - aircraft

MB - low altitude NVO - low-
altitude detector NVU - non-contact explosive device
NUR - unguided rocket OKS - operational command
communication OSO - optical detection
means PAD - powder pressure accumulator PBU -
combat control point air defense - air defense air defense SV
- air defense of ground forces ramjet - ramjet jet engine
PMV - extremely low altitudes PRP - passive
radio direction finder PRR - anti-radar missile PTK
- transmitting television camera PU - launcher

PUO - fire control point RV - radio fuse RVZ -
task line solid propellant rocket
engine RLI - radar information RLO - radar
detection radar - radar station RPZ - mission line RPK - radio
command transmitter RPU - distribution-converter device
RTR - electronic reconnaissance RUK -
reconnaissance and strike complex EW - electronic
warfare REZ - electronic defense REP -
electronic suppression SV - medium altitudes
SVN - air attack means SDC - selection of moving targets SKR - strategic
cruise missile SKTs - tracking target coordinator
SN - guidance station SNR - station CO missile guidance - fire
system

SOI - information display means SOA - self-propelled firing
system SOTs - target detection station SP - starting
position SPU - self-propelled launcher SR -
reconnaissance system SU - control
system SUBS - command and control system for combat
assets SUV - troop control system
SURN - self-propelled reconnaissance
and guidance system TVD - theater of military operations TZM - transport-
loading vehicle TKR - tactical KR TOV - teleoptical
sighting device TTZ - tactical-technical specification TTT - tactical-technical
requirements TTX - tactical-technical
characteristics UVK (UFK) - device for generating (forming)
SD commands - guided missile
PAR - phased antenna array CR - target
distribution TS - target designation COMPUTER -
electronic computer EPR - effective dispersion area

Anti-aircraft missile systems

Classification and combat properties of anti-aircraft missile systems

Anti-aircraft missile weapons are classified as missile weapons ground-to-air weapons and are intended to destroy the use of enemy air attack systems using anti-aircraft guided missiles (SAMs). It is presented in various mi systems.

An anti-aircraft missile weapon system (anti- aircraft missile system) is a combination of an anti-aircraft missile system (SAM) and the means that ensure its use. **Anti-aircraft missile system** - a set of functionally related combat and technical means designed to destroy air targets with anti-aircraft guided missiles.

The air defense system includes means of detection, identification and target designation, flight control means for missile defense systems, one or more launchers (PU) with missile defense systems, technical means sva and electrical power supplies.

The technical basis of the air defense system is the missile defense control system. Depending on the adopted control system, there are complexes for telecontrol of missiles, homing missiles, and combined control of missiles. Each air defense system has certain combat properties, features, the totality of which can serve as classification criteria.

signs that allow it to be classified as a specific type. **The combat properties of air defense systems** include all-weather capability, noise immunity, mobility, versatility, reliability, degree of automation of combat operations processes, etc.

All-weather capability - the ability of an air defense system to destroy air targets in any weather conditions. There are all-weather and non-all-weather air defense systems. The latter ensure the destruction of targets under certain weather conditions and time of day.

Noise immunity is a property that allows an air defense system to destroy air targets in conditions of interference created by the enemy to suppress electronic (optical) means. *Mobility is* a property that manifests itself in transportability and the time of transition from a traveling position to a combat position and from a combat position to a traveling position. A relative indicator of mobility can be the total time required to change the starting position under given conditions. An integral part of mobility is maneuverability. The most mobile complex is considered to be one that has greater trans-portability and requires less time to maneuver. Mobile systems can be self-propelled, towed and portable. Non-mobile air defense systems are called stationary. *Versatility* is a property that characterizes the technical capabilities of an air defense system to destroy air targets over a wide range of ranges and altitudes.

Reliability - the ability to function normally under specified operating conditions.

According to the degree of automation, anti-aircraft missiles are distinguished automatic, semi-automatic and non-automatic complexes. In automatic air defense systems, all operations to detect, track targets and guide missiles are performed automatically without human intervention. In semi-automatic and non-automatic air defense systems, the system takes part in solving a number of problems.
ness man.

Anti-aircraft missile systems are distinguished *by the number of target and missile channels.* Complexes that provide simultaneous tracking and firing of one target are called single-channel, and those of several targets are called multi-channel.

Based on their firing range, the complexes are divided into long-range (LR) air defense systems with a firing range of more than 100 km, medium-range (SD) with a firing range from 20 to 100 km, short-range (MD) with a firing range from 10 to 20 km and short-range (BD) with a firing range of up to 10 km.

Tactical and technical characteristics of the anti-aircraft missile system

Tactical and technical characteristics (TTX) determine the combat capabilities of the air defense system. These include: the purpose of the air defense system; range and altitude of destruction of air targets; the ability to destroy targets flying at different speeds; the probability of hitting air targets in the absence and presence of interference, when firing at maneuvering targets; number of target and missile channels; noise immunity of air defense systems; working hours of the air defense system (reaction time); time for transferring the air defense system from the traveling position to the combat position and vice versa (time of deployment and collapse of the air defense system at the starting position); movement speed; missile ammunition; power reserve; mass and dimensional characteristics, etc.

Performance characteristics are specified in the tactical and technical specifications for the creation of a new type of air defense system and are specified during field testing. The values of the performance characteristics are determined by the design features of the air defense missile system elements

The purpose of the air defense system is a generalized characteristic indicating the combat missions solved by means of this type of air defense system.

Engagement (firing) range is the range at which targets are hit with a probability not lower than the specified one. There are minimum and maximum ranges.

Hit altitude (shooting) - the altitude at which targets are hit with a probability not lower than the specified one. Once-
There are minimum and maximum heights. **Possibility of destroying targets , flying x with different speeds ,** is a characteristicindicating the maximum permissible value of the flight speeds of targets destroyed in given ranges of ranges and altitudes of their flight. The magnitude of the target's flight speed determines the values of the required missile overloads, dynamic guidance errors and the probability of hitting the target with one missile. At high target speeds, the necessary missile overloads and dynamic guidance errors increase, and the probability of destruction decreases. As a result, the values of the maximum range and height of destruction of targets are reduced.

The probability of damage is intact and is a numerical value, characterizing the possibility of hitting a target at given shooting conditions. Expressed as a number from 0 to 1.

The target can be hit when firing one or more how many missiles, so consider the corresponding probability of defeat P1 and Pn . **Target channel**

is a set of air defense missile system elements that ensures simultaneous tracking and firing of one target. There are single- and multi-channel air defense systems based on the target. The N-channel target complex allows you to simultaneously fire at N targets. The target channel includes a viewfinder and a device for determining

dividing the target coordinates.

Rocket channel l - a set of elements of an air defense system, providing baking at the same time preparation for the start, start and guidance firing one missile at a target. The missile channel includes: a launch device (launcher), a device for preparing for launch and launching a missile defense system, a sighting device and a device for determining the coordinates of the missile, elements of a device for generating and transmitting missile control commands. An integral part of the missile channel is the missile defense system. The air defense systems in service are single- and multi-channel. Portable complexes are made as single-channel ones. They allow only one missile to be aimed at a target at a time. Multi-channel missile-based air defense systems ensure simultaneous firing of several missiles at one or several targets. Such air defense systems have great capabilities for sequential firing of targets. To obtain a given value of the probability of destroying a target, the air defense system has 2-3 missile channels per target channel.

The following **indicators of noise immunity** are used: noise immunity coefficient, permissible interference power density at the far (near) border of the affected area in the area of the jammer, which ensures timely detection (opening) and destruction (defeat) of the target, range of the open zone , the range from which the target is detected (revealed) against the background

interference when the jammer sets it.

The operating time of the air defense system (reaction time) is the time interval between the moment of detection of an air target by air defense systems and the launch of the first missile. It is determined by time

which is spent on searching and capturing the target and preparing the initial data for shooting. The operating time of the air defense system depends on the design features and characteristics of the air defense system and the level of training of the combat crew. For modern air defense systems, its size is

on is in the range from units to tens of seconds.

Time to transfer from the air defense system to the traveling position n i l in combat - the time from the moment the command is given to transfer the complex to a combat position until the complex is ready to open fire. For MANPADS this time is minimal and amounts to several seconds. The time for transferring the air defense system to the combat position is determined by the initial state of its elements, the transfer mode and the type of power source. **Time to transfer the air defense system from the combat position to**

marching e - time from the moment the command is given to transfer the air defense system to the traveling position until the completion of the formation of the air defense system elements in the marching column.

Combat kit (bq) - number of missiles installed per one air defense system.

Travel distance a is the maximum distance that an air defense vehicle can travel after consuming a full load of fuel. **Mass characteristics and** -

maximum mass

high characteristics of elements (cabins) of air defense systems and missile defense systems.

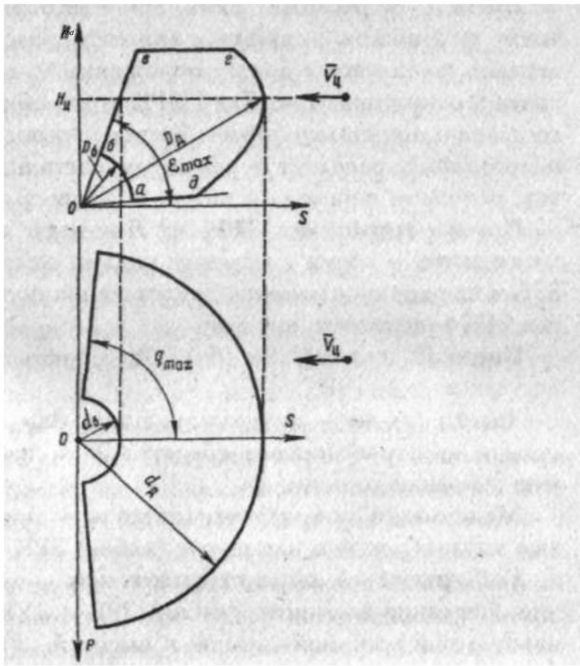
Dimensional characteristics and - the maximum external outlines of the elements (cabins) of the air defense system and missile defense system, determined by the greatest width, length and height.

SAM affected area

The kill zone of the complex is a region of space within which the destruction of an air target by an anti-aircraft guided missile is ensured under calculated firing conditions with a given probability. Taking into account the firing efficiency, it determines the reach of the complex in terms of height, range and heading parameters.

Design firing conditions - conditions under which the closing angles of the air defense missile system position are equal to zero, the characteristics and parameters of target movement (its effective reflective surface, speed, etc.) do not exceed specified limits, atmospheric conditions do not interfere with observation of the target .

Implementable kill zone is part of the kill zone in which it is possible to hit a target of a certain type under specific shooting conditions with a given probability. *The firing zone is* the space around the air defense system in which the missile is aimed at the target.



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Rice. 1. SAM **affected area : vertical *(a)* and horizontal (b) section**

The affected area is depicted in a parametric coordinate system and is characterized by the position of the far, near, upper and lower boundaries. Its main characteristics: horizontal (inclined) range to the far and near boundaries *dd (Dd)* and *dg (Dg),* minimum and maximum heights Hmin *and* Hmax , *maximum* heading angle *qmax* and maximum elevation angle *smax .* The horizontal range to the far border of the affected area and the maximum heading angle determine the limiting parameter of the affected area *Rpred* i.e. the maximum parameter of the target, which ensures its destruction with a probability not lower than the specified one. For many

A characteristic value of an air defense missile system on a target is also the parameter of the affected area *Rstr.o ,* up to which the number of firings carried out at the target is not less than with a zero parameter of its movement. Typical section of the affected area by vertical bisector and horizontal planes

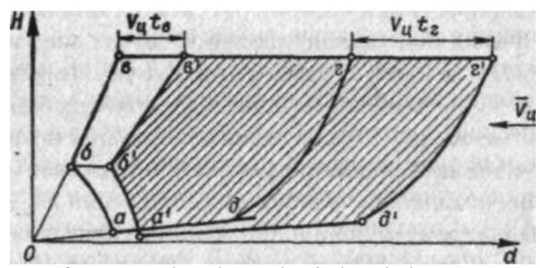
shown in the figure.

The position of the boundaries of the affected area is determined by a large number of factors related to the technical characteristics of individual elements of the air defense system and the control loop as a whole, firing conditions, characteristics and parameters of the movement of the air target. The position of the far border of the affected area determines the required range of action of the SNR. The position of the realized far and

lower boundaries of the SAM engagement zone may also depend on the terrain.

SAM launch area

In order for the missile to meet the target in the affected area, the missile must be launched in advance, taking into account the flight time of the missile and the target to the meeting point. *Missile launch zone is* a region of space in which, if the target is located at the moment of missile launch, their meeting is ensured in the air defense missile system's engagement zone. To determine the boundaries of the launch zone, it is necessary to set aside from each point of the affected zone to the side opposite to the target course a segment equal to the product of the target speed *Vt* by the flight time of the missile to a given point. In the figure, the most characteristic points of the launch zone are respectively indicated by the letters *a', 6' c' d' d'.*



Rice. 2. ***SAM*** *launch area (vertical section)*

When tracking a SNR target, the current coordinates of the point Meeting scores are usually calculated automatically and displayed on indicator screens. The rocket launch is carried out will occur when the meeting point is within the boundaries of the damage zone marriage.

Guaranteed launch zone - a region of space in which, if the target is located, at the moment of missile launch, the it meets the target in the affected area, regardless of type of anti-missile maneuver of the target.

Composition and characteristics of elements of anti-aircraft missile systems

In accordance with the tasks being solved, the functionally necessary elements of the air defense system are: means of detection, identification of aircraft and target designation; SAM flight controls; launchers and launching devices;

anti-aircraft guided missiles.

Can be used to combat low-flying targets man-portable anti-aircraft missile systems (MANPADS).

When multifunctional radars are used as part of air defense systems (Patriot, S-300), they serve as means of detection, identification, tracking devices for aircraft and missiles aimed at them, devices for transmitting control commands, as well as target illumination stations for ensuring the operation of the boron

commercial direction finders.

Detection Tools

In anti-aircraft missile systems, radar systems can be used as means of detecting aircraft.

tions, optical and passive direction finders.

Optical detection devices (ODF). Depending on the location of the source of radiant energy, optical detection means are divided into passive and semi-active. Passive OSOs, as a rule, use radiant energy caused by heating of the aircraft's skin and operating engines, or light energy from the Sun reflected from the aircraft. In semi-active NDEs on

At the ground control point there is an optical quantum generator (laser), the energy of which is used for space probing.

Passive OSO is a television-optical viewfinder, which includes a transmitting television camera (PTC), a synchronizer, communication channels, and a video control device (VCU).

The television-optical viewer converts the flow of light (radiant) energy coming from the aircraft into electrical signals, which are transmitted via a cable communication line and are used in the VKU to reproduce the transmitted image of the aircraft located in the field of view of the PTC lens .

In the transmitting television tube, the optical image is converted into an electrical one, and a potential relief appears on the photomosaic (target) of the tube, displaying in electrical form the brightness distribution of all points of the aircraft.

Reading of the potential relief occurs using the electron beam of the transmitting tube, which, under the influence of the field deflection coils moves synchronously with the electron beam chom VKU. A video image signal appears at the load resistance of the transmitting tube, which is amplified by a pre-amplifier and sent to the VCU via a communication channel. The video signal, after amplification in the amplifier, is fed to the control electrode of the receiving tube (kinescope). Synchronization of the movement of the electron beams of the PTC and VKU is carried out by horizontal and vertical scanning pulses, which are not mixed with the image signal, but are transmitted

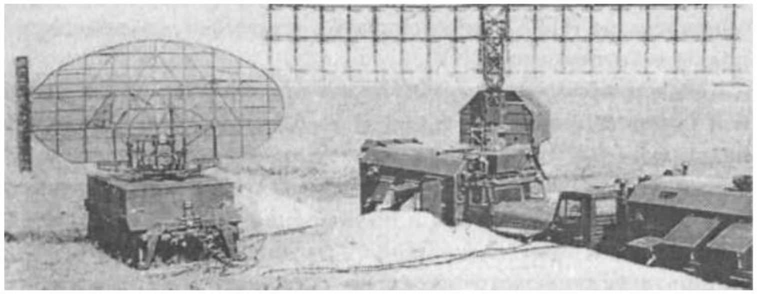
are transmitted via a separate channel.

The operator observes on the kinescope screen images of aircraft located in the field of view of the viewfinder lens, as well as sighting marks corresponding to the position of the TOV optical axis in azimuth (b) and elevation (e), as a result of which the azimuth and elevation angle of the aircraft can be determined.

Semi-active SOS (laser sights) are almost completely similar to radar sights in their structure, design principles and functions. They allow you to determine

divide the angular coordinates, range and speed of the target.

A laser beam is used as a signal source.



Radar detection equipment

transmitter, which is triggered by a synchronizer pulse. The laser light signal is emitted into space, reflected from the aircraft and received by the telescope.

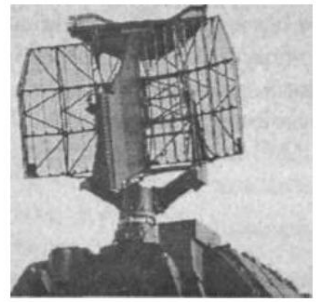
A narrow-band filter placed in the path of the reflected pulse reduces the impact of extraneous light sources on the operation of the viewfinder. Light pulses reflected from the aircraft enter a photosensitive receiver, are converted into video frequency signals and are used in units for measuring angular coordinates and range, as well as for displaying on

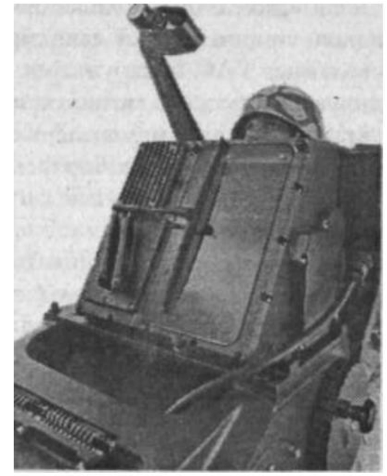
indicator screen.

In the angular coordinates measurement unit, control signals are generated for the optical system drives, which provide both an overview of the space and automatic tracking of the aircraft along angular coordinates (continuous alignment of the axis of the optical system with the direction to the aircraft).

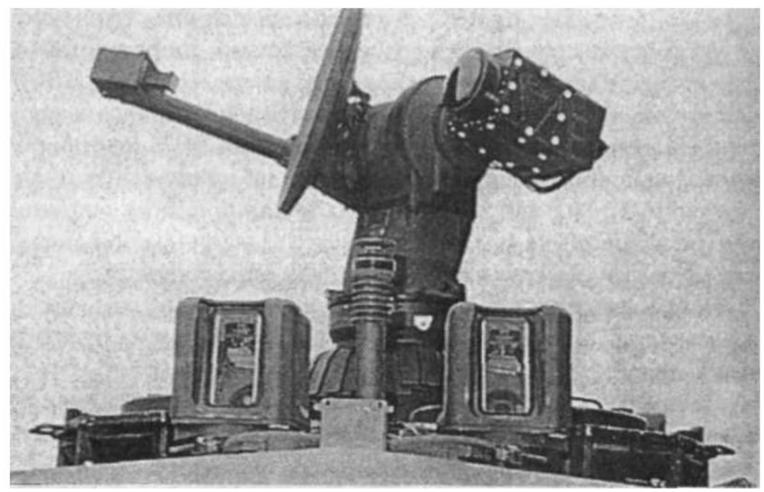
Aircraft identification means

Identification tools make it possible to determine the nationality of the detected aircraft and classify it as “friend or foe.” They can be combined and





“Top-Mi” detection radar antenna Optical detection means



Radar-optical detection means

autonomous. In co-located devices, the interrogation and response signals are emitted and received by the radar devices.

A request signal receiver is installed on "your" aircraft, which receives encoded request signals sent by the detection (identification) radar. The receiver decodes the request signal and if this signal matches

the established code issues it to the response signal transmitter installed on board "its" aircraft. The transmitter produces an encoded signal and sends it in the direction of the radar, where it is received, decoded and, after conversion, displayed on the indicator in the form of a conventional mark, which is displayed next to the mark from "its" aircraft. The enemy aircraft is on The radar request signal does not respond.

Target designation means

Target designation means are designed to receive, process and analyze information about the air situation and determine the sequence of fire on detected targets, as well as transmitting data about them to other combat units.

facilities.

Information about detected and identified aircraft, as a rule, comes from the radar. Depending on the type of target designation device, the analysis of information about the aircraft is carried out automatically (when using a computer) or manually (by an operator when using cathode ray tube screens). The results of a computer solution (calculating device) can be displayed on special consoles, indicators or in the form of signals for the operator to make a decision on their further use, or be automatically transmitted to other air defense systems.

If a screen is used as end devices, then marks from detected aircraft are displayed in light

signs.

Target designation data (decisions to fire at targets) can be transmitted both via cable lines and radio links.

communication pits.

Target designation and detection means can serve both one and several air defense units.

SAM flight controls

When an aircraft is detected and identified, an analysis of the air situation, as well as the order of firing at targets, is carried out by the operator. At the same time, devices for measuring range, angular coordinates, speed, generating control commands and transmitting commands (command radio control line), auto-pilot and missile steering tract are involved in the operation of the missile defense flight control systems. *The range measuring device* is designed to measure the slant range to aircraft and missile defense systems. Determination of range is based on the straightness of propagation of electromagnetic

waves and the constancy of their speed. The range can be measured by location and optical means. For this purpose, the signal travel time from the radiation source to the aircraft and back is used. Time can be measured by the delay of the pulse reflected from the aircraft, the magnitude of the change in the frequency of the transmitter, and the magnitude of the change in the phase of the radar signal. Information about distance

distance to target is used to determine the launch moment
SAM, as well as for generating control commands (for systems with remote control).

The angular coordinates measuring device is designed to measure the elevation angle *(e)* and azimuth (b) of an aircraft and missile defense system. The measurement is based on the property of rectilinear propagation
of electromagnetic waves.

The speed measuring device is designed to measure the radial speed of the aircraft. The measurement is based on the Doppler effect, which consists in changing the frequency of the reflected signal from moving objects.

The control *command generating device* (UFC) is designed to generate electrical signals, the magnitude and sign of which correspond to the magnitude and sign of the missile's deviation from the kinematic trajectory. The magnitude and direction of deviation of the missile from the kinematic trajectory are manifested in the disruption of connections determined by the nature of the target's movement and the method of aiming the missile at it. The measure of violation of this connection is called the mismatch parameter *A(t).*

The value of the mismatch parameter is measured by means -

systems for tracking air defense missile systems, which, based on *A(t),* generate a corresponding electrical signal in the form of voltage or current, called a mismatch signal. The error signal is the main component in the formation of a control command. To improve accuracy

When aiming a missile at a target, some correction signals are introduced into the control command. In telecontrol systems when implementing the three-point method for reduction

the time of launching the missile to the meeting point with the target, as well as reducing errors in pointing the missile at the target, a damping signal and a signal for compensating for dynamic errors caused by the movement of the target and the mass (weight) of the missile can be introduced into the control command. *Device for transmitting* control commands (control radio command lines). In telecontrol systems, the transmission

of control commands from the guidance point to the on-board missile defense device is carried out through equipment that forms a command radio control line. This line provides

transmits rocket flight control commands, one-time commands that change the operating mode of the onboard equipment. The command radio line is a multi-channel communication line, the number of channels of which corresponds to

number of transmitted commands during simultaneous control several missiles.

The autopilot is designed to stabilize the angular movements of the rocket relative to the center of mass. In addition, the autopilot is an integral part of the flight control system

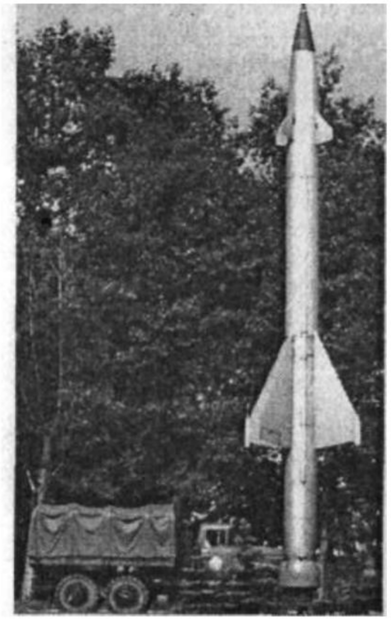
rocket and controls the position of the center of mass in the pro- travel in accordance with control commands.

Launchers, starting devices

Launchers (PU) and launching devices are special devices designed for placement, aiming, pre-launch preparation and launch of a rocket. The launcher consists of a launch table or guides, aiming mechanisms, leveling means, test and launch app.

parameters, power supplies.

Launchers are distinguished by the type of missile launch -



Stationary launcher C-25 with vertical launch

Portable anti-aircraft missile system "Igla"

Launcher of the Blowpipe man-portable anti-aircraft missile system with three guides

with vertical and inclined launch, in terms of mobility - stationary, semi-stationary (collapsible), mobile.

Stationary launchers in the form of launch pads are mounted on special concrete platforms and moved

are not subject to

Semi-stationary launchers, if necessary, can be disassembled and, after transportation, installed on another

positions.

Mobile launchers are placed on special vehicles. They are used in mobile air defense systems and are manufactured in self-propelled, towed, portable (portable) versions. Self-propelled launchers are placed on tracked or wheeled chassis, providing a quick transition from the traveling position to the combat position and back. Towed launchers installed

are mounted on tracked or wheeled non-self-propelled chassis, transported by tractors.

Portable launching devices are made in the form of launch tubes into which the rocket is installed before launch. The launch tube may have an aiming device for pre-targeting and a trigger mechanism.

According to the number of missiles located on the launcher

ke, there are single PUs, paired ones, etc.

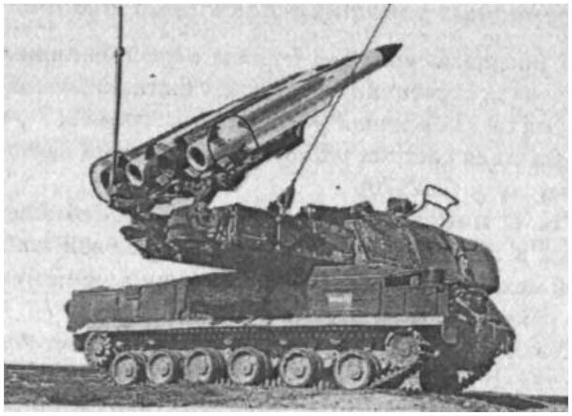
Anti-aircraft guided missiles

Anti-aircraft guided missiles are classified by the number of stages, aerodynamic design, guidance method, and type of warhead.

Most missiles can be one- or two-stage. According to the aerodynamic design, they distinguish between missiles made according to the normal design, the “swivel wing” design, and also the “canard” design.

Based on the guidance method, a distinction is made between homing and remote- controlled missiles. A homing rocket is a missile that has flight control equipment installed on board. Remote-controlled missiles are called missiles controlled (guided) by ground control (guidance) means.

Based on the type of warhead, missiles with conventional and nuclear warheads are distinguished.



Self-propelled PU air defense missile system "Buk" with inclined launch

Semi-stationary S-75 air defense missile launcher with inclined launch

Self-propelled PU SAM S-300PMU with vertical launch

Man-portable anti-aircraft missile systems

MANPADS are designed to combat low-flying targets. The construction of MANPADS can be based on a passive homing system (Stinger, Strela-2, 3, Igla), a radio command system (Blowpipe), a laser beam guidance system (RBS-70). **MANPADS with a passive homing system** include a launcher (launch container), a trigger mechanism, identification equipment, and an anti-aircraft guided

missile. The launcher is a sealed fiberglass tube in which the missile defense system is stored. The pipe is sealed. Outside the tube there are sighting devices for preparing the missile launch and the launch pad.

chanism.

The launching mechanism ("Stinger") includes an electric battery for powering the equipment of both the mechanism itself and the homing head (before launching the rocket), a cylinder with
refrigerant for cooling the thermal radiation receiver
of the seeker during preparation of the rocket for launch, a switching device that provides the necessary sequence
passage of commands and signals, indicator device. Identification equipment includes an identification

antenna and an electronic unit, which includes a transceiver device, logic circuits, a computing device, and a power source.

The missile (FIM-92A) is single-stage, solid propellant. The homing head can operate in the IR and ultraviolet ranges, the radiation receiver is cooled. Aligning the axis of the seeker optical system with the direction towards the target

in the process of its accompaniment is carried out using hy-
roscopic drive.

A rocket is launched from a container using a launch accelerator. The main engine turns on,
when the rocket moves away to a distance at which
the anti-aircraft gunner is likely to be hit by a jet from a working
engine.

The radio command PZR K includes a transport and launch container, a guidance unit with identification equipment and an anti-aircraft guided missile. The container is interfaced with the missile and guidance unit located in it during the process of preparing the MANPADS for combat use.

I don't think so.

There are two antennas on the container: one is a command transmission device, the other is identification equipment. Inside the container is the rocket itself. The guidance unit includes a monocular optical sight that provides target acquisition

and tracking, an IR device for measuring the missile's deviation from the target's line of sight, a device for generating and transmitting guidance commands, a software device for launch preparation and production, and an identification equipment interrogator. one's own or another's." There is a controller on the block body that is used when guiding

aiming the missile at the target.

After launching the missile, the operator follows it along the tail IR tracer using an optical sight. The launch of the missile to the line of sight is carried out manually or automatically. In automatic mode, the deviation of the missile from the line of sight, measured by the IR device, is converted into guidance commands

transmitted to the missile defense system. The IR device is turned off after 1-2 seconds of flight, after which

the missile is aimed at the meeting point manually, provided that the operator achieves alignment of the target image and the missile in the field of view of the sight by changing the position of the control switch. Control commands are transmitted to the missile defense system, ensuring its flight along the required trajectory.

In complexes that provide **guidance of missiles using a laser** beam (RBS-70), laser radiation receivers are placed in the tail section of the missile to guide the missile to the target, which generate signals that control the flight of the missile. The guidance unit includes an optical sight and a device for generating a laser beam with focusing that varies depending on the distance of the missile defense system.

Anti-aircraft missile control systems

Telecontrol systems

Telecontrol systems are those in which the movement of the missile is determined by the ground guidance point niya, continuously monitoring trajectory parameters targets and missiles. Depending on the location of the formation of commands (signals) for controlling the rocket's rudder, these systems de- include beam guidance and command systems telecontrol.

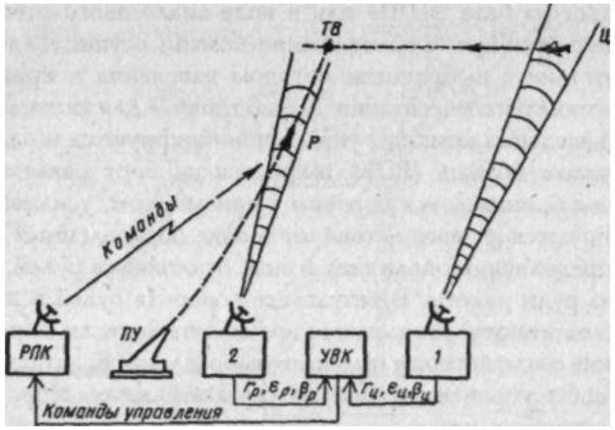
In beam guidance systems, the direction of movement of the missile is you are set using directed radiation of electro- magnetic waves (radio waves, laser radiation, etc.). The beam is modulated in such a way that when the rocket deviates from a given direction, its on-board devices automatically detect mismatch signals and generate appropriate rocket control commands.

An example of the use of such a control system with a tele-oriented missile in a laser beam (after its launch into this beam) is the ADATS multi-purpose missile system, developed by the Swiss company Oerlikon together with the American Martin Marietta. It is believed that this method of control, in comparison with the command telecontrol system of the first type, provides more

high accuracy of missile guidance to the target.

In command telecontrol systems, missile flight control commands are generated at the guidance point and transmitted via a communication line (telecontrol line) to the missile board. Depending on the method of measuring target coordinates and determining adjusting its position relative to the missile command systems telecontrol systems are divided into telecontrol systems of the first type and telecontrol systems of the second type. In systems first This type of measurement of the current coordinates of the target is carried out directly by the ground guidance point, and in systems of the second type - by the onboard missile coordinator with their subsequent transfer to the guidance point. The development of rocket control commands in both the first and second cases is carried out

is determined by the ground guidance point.



Rice. 3. Command telecontrol system

Determination of the current coordinates of the target and the missile (for example, range, azimuth and elevation) is carried out by a tracking radar station. In some complexes

this problem is solved by two radars, one of which One accompanies the target (target sighting radar 7), and the other accompanies the missile (missile sighting radar *2).*

Target sighting is based on the use of the principle of active radar with a passive response, i.e., on obtaining information about the current coordinates of the target from radio signals reflected from it. Target tracking can be automatic (AS), manual (PC) or mixed. Most often, target sighting devices have devices that provide various types of target tracking. Automatic tracking is carried out without operator participation, manual and

mixed - with the participation of the operator.

To sight a missile in such systems, as a rule, active response radar links are used. A transceiver is installed on board the rocket, emitting response pulses to request pulses sent by the guidance point. This method of sighting a missile ensures its stable automatic tracking, including when firing at significant distances.

The measured values of the coordinates of the target and the missile are fed into the command generation device (CDD), which can generate

rise on the basis of a digital computer or in the form of an analog computing device. Commands are generated in accordance with the selected guidance method and the accepted mismatch parameter. The control commands generated for each guidance plane are encrypted and issued on board the rocket by a radio command transmitter (RPK). These commands are received by the on-board receiver, amplified, deciphered and, through the autopilot, in the form of certain signals that determine the magnitude and sign of the rudder deflection, issued to the rocket's rudder. As a result of the rotation of the rudders and the appearance of angles of attack and sliding, lateral aerodynamic forces arise that change the direction of the rocket's flight. The rocket control process is carried out continuously

before she meets the target.

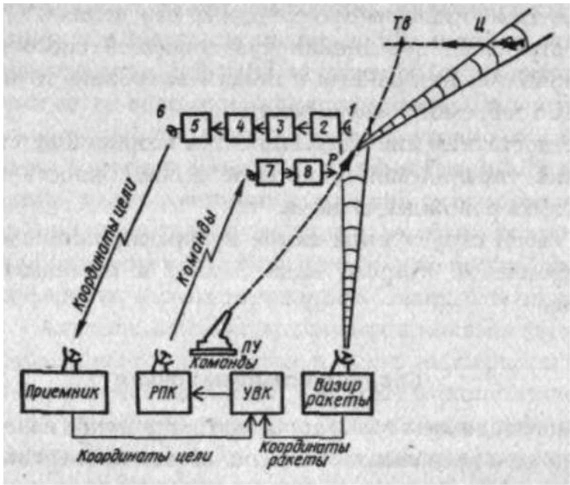
After the missile is launched into the target area, as a rule, with the help of a proximity fuse, the problem of choosing the moment to detonate the warhead of an anti-aircraft guided missile is solved. The command

telecontrol system of the first type does not require an increase in the composition and mass of on-board equipment, and has greater flexibility in the number and geometry of possible rocket trajectories. The main drawback of the system is the dependence of the magnitude of the linear error in pointing the missile at the target on the firing range. If, for example, the magnitude of the angular guidance error is taken to be constant and equal to 1/1000 of the range, then the missile miss at firing ranges of 20 and 100 km will be 20 and 100 m, respectively. In the latter case, to hit the target, an increase in the mass of the warhead will be required, and therefore , and the launch mass of the rocket. Therefore, the system

The first type of telecontrol device is used to engage missile defense targets at short and medium ranges.

In the telecontrol system of the first type, the impact

The fur is subject to target and missile tracking channels and a radio control line. Foreign experts associate the solution to the problem of increasing the noise resistance of this system with the use, including in a comprehensive manner, of target and missile sighting channels of different frequency ranges and operating principles (radar, infrared, visual, etc.), as well as radar stations with phased array antennas (PAR).



Rice. 4. Command telecontrol system of the second type

The target coordinator (direction finder) is installed on board the missile. It tracks the target and determines its current coordinates in a moving coordinate system associated with the missile. The coordinates of the target are transmitted via the communication channel to the guidance point. Therefore, an onboard radio direction finder generally includes an antenna for receiving target signals *(7),* a receiver *(2),* a device for determining target coordinates (3), an encoder *(4),* a signal transmitter *(5)* containing information about the target coordinates, and transmitting - antenna *(6).* The target coordinates are received by the ground guidance

point and fed into the device for generating control commands. From the missile tracking station (radio sighter), the UVK also receives the current coordinates of the anti-aircraft guided missile. The command generation device determines the mismatch parameter and generates control commands, which, after appropriate transformations by the command transmission station, are issued on board the rocket. To receive these commands, convert them and work them out by the rocket on board

the same equipment is installed as in television systems

control of the first type (7 - command receiver, *8* - autopilot). The advantages of the second type of telecontrol system are

are based on the independence of the missile guidance accuracy from the firing range, the increase in resolution as the missile approaches the target and the ability to aim the required number of missiles at the target. The disadvantages of the system include the increasing cost of an anti-aircraft guided missile and the impossibility

of modes

manual target tracking.

In its structural diagram and characteristics, the telecontrol system of the second type is close to self-control systems.

management

Homing systems

Homing is the automatic guidance of a missile at a target, based on the use of energy coming from

from target to missile.

The missile's homing head autonomously carries out

target tracking, determines the mismatch parameter and generates missile control commands.

Based on the type of energy that the target emits or reflects, homing systems are divided into *radar* and *optical* (infrared or thermal, light, laser, etc.). Depending on *the location of the primary energy* source , homing systems can be *passive, ac-*

active and *semi-active.*

With passive homing, the energy emitted or reflected by the target is created by the sources of the target itself or the target's natural irradiator (Sun, Moon). Consequently, information about the coordinates and parameters of the target's movement can be obtained without special irradiation of the target with any type of energy.

The active homing system is characterized by the fact that the energy source irradiating the target is installed on the missile and the missiles reflected from the missile are used for homing.

targets the energy of this source.

With semi-active homing, the target is irradiated first

primary source of energy located outside the target and

missiles (Hawk air defense system).

Radar homing systems have become widespread in air defense systems due to their practical independence of action from meteorological conditions and the ability to point a missile at a target of any type and at various ranges. They can be used throughout or only at the final section of the trajectory of an anti-aircraft guided missile, i.e. in combination with other control systems (telecontrol system, program control). In radar systems, the use of passive homing is very limited. This method is possible

only in special cases, for example, when homing a missile defense system at an aircraft that has a continuously operating radio jammer on board. Therefore, in radar homing systems, special irradiation ("illumination") of the target is used. When homing a missile at

throughout the entire section of its flight path to the target, as a rule, along energy and cost ratios, semi-active homing systems are used. The primary energy source (target illumination radar) is usually located at the guidance point. In combined systems it is used

There are both semi-active and active homing systems. The range limitation of the active homing system occurs due to the maximum power that can be obtained on the rocket, taking into account the possible dimensions and weight of the on-board equipment, including the head antenna

homing.

If homing does not begin from the moment the missile is launched, then with an increase in the firing range of the missile, the energy

ical advantages of active homing compared to

nia with semi-active increase. To calculate the

mismatch parameter and generation

control commands, the tracking systems of the homing head must continuously track the target.

At the same time,

generation of control commands is possible with accompaniment

of the target only by angular coordinates. However, such tracking does not provide target selection

by range.

and speed, as well as protection of the homing head receiver from side information and

interference.

For automatic target tracking along angular co-

Equal-signal direction-finding methods are used for ordinates. The angle of arrival of the wave reflected from the target is determined by comparing signals received from two or more divergent radiation patterns. Comparison can be done

occur simultaneously or sequentially.

The most widely used are direction finders with an instantaneous equal-signal direction, which use a sum-difference method for determining the angle of target deflection. The appearance of such direction-finding devices is primarily due to the need to improve the accuracy of automatic target tracking systems in direction. Such

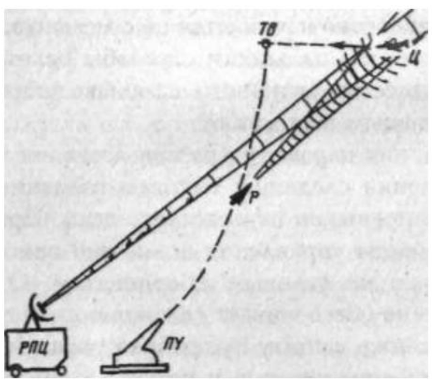
Direction finders are theoretically insensitive to amplitude fluctuations of the signal reflected from the target.

In direction finders with an equal-signal direction, creating
By periodically changing the radiation pattern of the antenna, and, in particular, with a scanning beam, a random change in the amplitudes of the signal reflected from the target is perceived as a random change in the angular position of the target.

The principle of target selection by range and speed depends on the nature of the radiation, which can be pulsed or continuous.

With pulsed radiation, target selection is carried out, as a rule, by range using strobing

pulses opening the homing head receiver
at the moment of arrival of signals from the target.



Rice. 5. *Radar semi-active* homing system

With continuous radiation, it is relatively simple to select a target by speed. The Doppler effect is used to track the target by speed. The magnitude of the Doppler frequency shift of the signal reflected from the target is

with active homing, it is proportional to the relative speed of approach of the missile to the target, and with semi-active homing, it is proportional to the radial component of the target's speed relative to the ground-based irradiation radar and the relative speed of approach of the missile to the target. For

To isolate the Doppler shift during semi-active homing on a missile after target acquisition, it is necessary to compare the signals received by the irradiation radar and the homing head. The configured filters are

homing heads are passed into the change channel
angle changes only those signals that were reflected from a target moving at a certain speed relative to the missile. In relation to the Hawk type anti-aircraft missile system, it includes a

target irradiation (illumination) radar,

semi-active homing head, anti-aircraft controlled
missile, etc. The

task of the target irradiation (illumination) radar is to continuously irradiate the target with electromagnetic energy. The radar station uses directed radiation of electromagnetic energy, which requires continuous tracking of the target along angular coordinates. To solve other problems, target tracking in range and speed is also provided. Thus, the ground part of the semi-active homing system is

radar station with continuous automatic
accompaniment of the target.

The semi-active homing head is installed on the rocket and includes a coordinator and a computing device. It provides target acquisition and tracking by angular coordinates, range or speed (or all four coordinates), determination of the mismatch parameter and generation of control commands. An autopilot is installed on board the anti-aircraft guided missile, solving the same problems as in command systems.

topics of telecontrol.

An anti-aircraft missile system using a homing system or a combined control system also includes equipment and equipment that ensure

those involved in preparing and launching missiles, pointing the radiation radar at a target, etc.

Infrared (thermal) self-heating systems conducting anti-aircraft missiles use a wave range, usually from 1 to 5 microns. This range contains the maximum thermal radiation of most airborne targets. The possibility of using a passive homing method is the main advantage of infrared systems. The system is made simpler, and its action is hidden from the enemy. Before launching a missile defense system, it is more difficult for an airborne enemy to detect such a system, and after launching a missile, it is more difficult to actively interfere with it. The design of an infrared system receiver can be much simpler than that of a radar seeker receiver.

The disadvantage of the system is the dependence of the range on meteorological conditions. Heat rays are greatly attenuated in rain, fog, and clouds. The range of such a system also depends on the orientation of the target relative to the energy receiver (on the direction of reception). The radiant flux from the nozzle of an aircraft jet engine significantly exceeds the radiant flux of its fuselage.

Thermal homing heads have become widespread in close-range and short-range anti-aircraft missiles. **Light homing systems** are based on the fact that most aerial targets reflect sunlight or moonlight much more strongly than the background surrounding them. This allows you to select a target against a given background and aim an anti-aircraft missile at it using a seeker that receives a signal in the visible part of the electrical spectrum.

magnetic waves.

The advantages of this system are determined by the possibility of using a passive homing method. Its significant drawback is the strong dependence of the range on meteorological conditions. With good meteorologists - under technical conditions, light homing is also impossible in the directions where the light of the Sun and Moon falls into the field of view of the system’s protractor.

Combined control

Combined control means a combination the use of various control systems when pointing a missile at a target. In anti-aircraft missile systems it is used when firing at long ranges to obtain the required accuracy of missile guidance at the target with permissible mass values of the missile defense system. The following sequential combinations of control systems are possible: telecontrol of the first type and homing, telecontrol of the first and second types, automatic Nominal system and homing.

The use of combined control makes it necessary to solve such problems as pairing trajectories when switching from one control method to another, ensuring target acquisition by the missile homing head in flight, using the same on-board equipment devices on different stages of management, etc.

At the moment of transition to homing (telecontrol of the second type), the target must be within the radiation pattern of the receiving antenna of the seeker, the width of which usually does not exceed 5-10°. In addition, guidance of tracking systems must be carried out: seeker by range, by speed or by range and speed, if target selection according to these coordinates is provided to increase the resolution and noise immunity of the control system.

The aiming of the seeker at the target can be done in the following ways: by commands transmitted on board the missile from guidance point; enabling autonomous automatic search for the seeker target by angular coordinates, range and frequency; a combination of preliminary command guidance of the seeker at the target with subsequent search for the target.

Each of the first two methods has its own advantages and significant disadvantages. The task of ensuring reliable guidance of the seeker to the target during the missile's flight to the target is quite complex and may require the use of a third method. Preliminary guidance of the seeker allows you to narrow the target search range.

When combining telecontrol systems of the first and second types after the start of operation of the on-board radio direction finder into the device for generating commands from the ground point

guidance can receive information simultaneously from two sources: a target and missile tracking station and an on-board radio direction finder. Based on the comparison, we formed

Given commands based on data from each source, it seems possible to solve the problem of matching trajectories, as well as increase the accuracy of missile pointing to the target (reduce random error components by selecting a source, weighing the variances of the generated commands). This method of combining control systems is called bi-

national management.

Combined control is used in cases where the required characteristics of an air defense system cannot be achieved using only one control system.

Autonomous control systems

Autonomous control systems are those in which flight control signals are generated on board the rocket in accordance with a pre-set program (before launch). When a missile is in flight, the autonomous control system does not receive any information from the target and the control point. In a number of cases such a system is used

is located at the initial section of the rocket's flight path to launch it into a given area of space.

Elements of missile control systems

A guided missile is an unmanned aircraft with a jet engine designed to destroy air targets. All onboard devices are located on the rocket airframe. *The glider is* the supporting structure of the rocket, which consists of

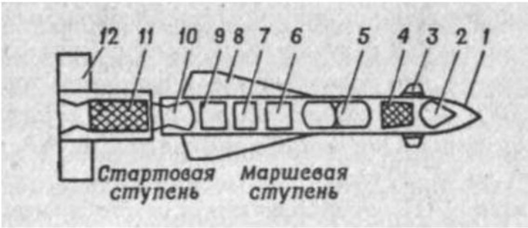
body, fixed and movable aerodynamic surfaces

news The glider body is usually cylindrical in shape with a conical (spherical, ogival) head part.

The airframe's *aerodynamic surfaces* serve to create lift and control forces. These include wings, stabilizers (fixed surfaces), and rudders. Based on the relative position of the rudders and fixed aerodynamic surfaces, the following aerodynamic surfaces are distinguished:

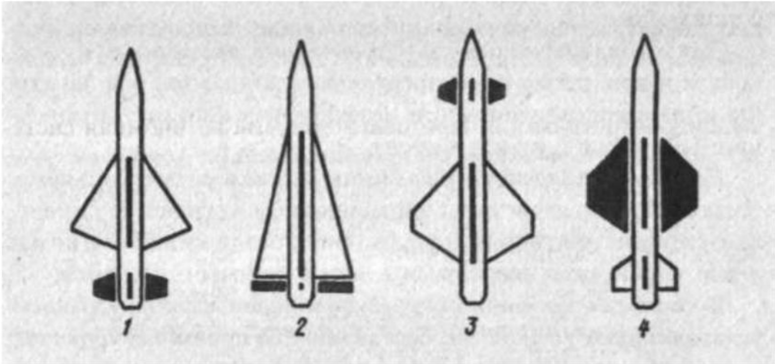
rocket designs: normal, tailless, canard, rotary

wing".



Rice. b. Layout diagram of a hypothetical guided missile:

) - rocket body; 2 - non-contact fuse; 3 - rudders; 4 - warhead; 5 - tanks for fuel components; b - autopilot; 7 - control equipment; 8 - wings; 9 - sources of on-board power supply; 10 - propulsion stage rocket engine ; 11 - launch stage rocket engine; 12 - stabilizers.



Rice. 7. Aerodynamic designs of guided missiles:

1 - normal; 2 - “tailless”; 3 - “duck”; 4 - “swivel wing”.

Guided missile *engines* are divided into two groups: jet and air-jet.

A rocket engine is an engine that uses fuel that is entirely on board the rocket. Its operation does not require oxygen intake from the environment. By

type of fuel, rocket engines are divided into rocket engines solid fuel engines (solid propellant motors) and liquid rocket engines (LPRE). Solid propellant rocket engines use rocket powder and mixed solid fuel as fuel, which

poured and pressed directly into the combustion chamber engine.

Air-breathing engines (ARE) are engines in which the oxidizing agent is oxygen taken from the surrounding air. As a result, only fuel is contained on board the rocket, which makes it possible to increase the fuel supply. The disadvantage of WFDs is the impossibility of their operation in rarefied layers of the atmosphere. They can be used on aircraft at flight altitudes of up to 35–40 km.

The autopilot (AP) is designed to stabilize the angular movements of the rocket relative to the center of mass. In addition, the AP is an integral part of the control system

the flight of the rocket and controls the position of the center itself masses in space in accordance with control commands nia. In the first case, the autopilot plays the role of a rocket stabilization system, in the second - the role of an element of the system management. To

stabilize the rocket in the longitudinal, azimuthal planes and when moving relative to the longitudinal axis of the rocket (along the roll), three independent stabilization channels are used: pitch, heading and roll. *Onboard missile flight control equipment* is an integral part of the control system. Its structure is determined by the adopted

control system implemented in the computer.

lex for controlling anti-aircraft and aircraft missiles.

In command telecontrol systems, devices are installed on board the rocket that make up the receiving path of the command radio control link (CRU). They include

antenna and receiver of radio signals of control commands, se- command lecturer, demodulator.

The combat equipment of anti-aircraft and aircraft missiles is a combination of a warhead and a fuse.

The warhead has a warhead, a detonator and a housing. According to the principle of operation, warheads can be fragmentation and high-explosive fragmentation. Some types of missile defense systems can also be equipped with nuclear warheads (for example, in the Nike-Hercules

air defense system). The damaging elements of the warhead are: fragments and finished elements placed on the surface

hundred buildings. High explosives (crushing) explosives (TNT, mixtures of TNT with hexogen, etc.) are used as warheads.

Missile fuses can be non-contact or contact. Non-contact fuses depending on the location of the energy source used for operation

fuses are divided into active, semi-active and passive. In addition, non-contact fuses are divided into electrostatic, optical, acoustic, and radio fuses. In foreign missile models, radio and optical fuses are more often used. In some cases, an optical and radio fuse operate simultaneously, which increases the reliability of detonating a warhead in conditions

electronic suppression.

The operation of a radio fuse is based on the principles of radar. Therefore, such a fuse is a miniature radar that generates a signal

breakthrough at a certain target position in the antenna beam fuse.

According to the design and principles of operation, radio fuses can be can be pulse, Doppler and frequency.

Rice. 8. Block *diagram of a pulse radio fuse*

In a pulse fuse, the transmitter produces high-frequency pulses of short duration, emitted by the antenna in the direction of the target. The antenna beam is coordinated in space with the area of dispersion of warhead fragments. At

When the target is in the beam, the reflected signals are received by the antenna, pass through the receiving device and arrive at the coincidence cascade, where a strobe pulse is applied. When they coincide

When the detonator of the warhead is detonated, a signal is issued. The duration of the strobe pulses determines the range of possible firing ranges of the fuse.

Doppler fuses often operate in continuous radiation mode. The signals reflected from the target and received by the antenna are sent to a mixer, where the Doppler frequency is separated. At given speed values, Doppler frequency signals

pass through the filter and are fed to the amplifier. At a certain amplitude of current oscillations of this frequency,

The detonation signal sounds.

Contact fuses can be electric or impact. They are used in short-range missiles with high firing accuracy, which ensures detonation of the warhead in the event of a direct missile hit.

To increase the likelihood of hitting a target with warhead fragments, measures are taken to coordinate the areas of fuse activation and the dispersion of fragments. With good coordination, the area of scattering of fragments, as a rule, coincides in space with the area where the target is located.

PORTABLE ANTI - AIRMISSILE SYSTEMS

Blowpipe
(UK)

In the early 60s, Great Britain began creating portable air defense systems (later called "Blowpipe") to protect the battlefield from aircraft. The first tests of the complex's missiles took place in 1965, and in September 1966 the missile system was officially presented at the Farnborough air show. In 1968, by order of the UK Ministry of Defense, production of the Blowpipe MANPADS began. At the beginning of

1972, after factory tests, the MANPADS were adopted by the British Army.

The main purpose of the Blowpipe MANPADS is to combat air stuffy targets, but it can also be used against ground targets at ranges up to 3000 m.

In 1979, a promising guidance system for the Blowpipe complex was successfully tested. Further development of the system made it possible to create the Blowpipe Mk.2 complex, which is better known as the Javelin.

The British Army has air defense battalions armed with Blowpipe MANPADS, each with two platoons, three squads with four MANPADS each.

By the end of 1989, 19,000 Blowpipe missiles had been fired and 16,000 Javelin missiles.

MANPADS "Blowpipe" consists of a missile in a transport-launch in the container and the aiming unit.

The Blowpipe missile is a thin tube 1.4 m long, with a warhead in the central section. The guidance and fuse equipment is located in the bow, and the rocket engine is located in the tail.

Initial movement (for 0.2 seconds) rocket receives due to the operation of the accelerator.

To reduce the smoke effect in the second stage, use uses special fuel and removes gas calling through special holes. A special partition is

mounted between the first and second stages, which prevents the premature launch of the second stage. There are four delta-shaped aerodynamic wings in the nose, and four wings in the tail for stabilization and aerodynamic control. In both cases, the wings have a supersonic aerodynamic profile.-

If no guidance commands are received on board the rocket within the first five seconds, then its self-propelled liquidator.

The Blowpipe missile is unusual in that its nose is free to rotate independently of the rest of the missile. The transport and launch container in which it is located is designed to minimize recoil. It houses a reusable starting device, a power source for the aiming unit,

guidance system and electrical contacts.

The aiming unit is an autonomous device consisting of a firing unit and a guidance (control) unit. On

The TPK houses a pistol grip, a transmitter, a data acquisition device, a monocular sight and an IR optical system. The control system includes a trigger mechanism, a hand-operated joystick, a selectable switch

type of fuse and guidance command transmitter.

Information about an approaching target is received by radio channel of the warning system or as a result of visual the shooter's inspection of the horizon. The

Blowpipe MANPADS can be prepared for use in less than 5 seconds by connecting the TPK to the sighting unit. The shooter holds the bow with his left hand, and with his right hand squeezes the handle with the trigger mechanism. In this case, the TPK lies on the shooter's right shoulder.

The shooter locks onto the target with his monocular sight the crowbar, which has a fivefold amplification, estimates the range and makes adjustments for the direction and strength of the wind. Then the shooter turns on the equipment, selects the frequency of the command transmitter and the type of fuse used (contact or non- contact).

In addition to the monocular sight, a sensor is connected to the aiming unit that determines the position of the missile relative to the line of sight. The Blowpipe missile has flyers (signal lights) that provide flight monitoring and automatic IR tracking. The error signal is generated by the sensor and sent to the missile using a command transmitter located on the MANPADS.

The receiver on the rocket receives these signals and transmits them to the control unit, and the rocket automatically processes them using the rudders. Effective missile range limited by speed and maneuverability during the final phase of flight after the second stage of the engine is turned off. The automatic guidance system is more effective than the shooter and allows you to destroy targets at the nearest border. For targets at the far edge of the affected area, automatic guidance is carried out for 2-3 seconds, and then manual guidance occurs using the shooter's joystick.

For safety reasons, the shooter is provided with protection new uniform.

When the trigger is pressed, the generator is started, which powers the TPK and the rocket, and then the rocket's gyroscope. The missile is launched using a launch engine similar to the Javelin MANPADS, which operates while in the TPK and turns off when leaving it. The main engine is started at a safe distance from the shooter, and the missile develops supersonic speed. The shooter aims the missile at the target using a hand joystick.

The shooter keeps the missile on the target's line of sight until they meet. When a joystick is used to guide a missile, there is no need to accurately track the target. The operator only needs to keep it in sight

monocular.

When not to use automatic guidance chum, the shooter turns it off before launching and uses only to manual guidance.

The warhead of a Blowpipe missile is detonated either by a contact or proximity fuse. A high-explosive type warhead is capable of penetrating the armor of lightly armored

chassis. When firing is completed, instead of an empty container, a whole TPK is attached to the aiming unit, and the empty can be reused.

In the spring of 1986, several Blowpipe systems fell to the Afghan Mujahideen and Nicaraguan contras. The Moja Heads used the Blowpipe as an anti-tank weapon and also used it to destroy armored personnel carriers.

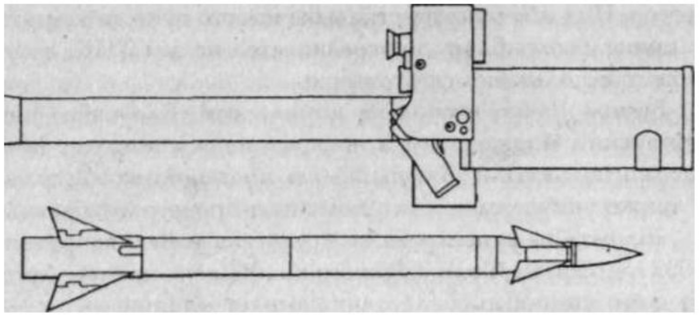
The blowpipe was used by Argentina and Great Britain in 1982 during the Falklands conflict, and Argentina used it to shoot down one Harrier aircraft.

The Blowpipe MANPADS requires more training time than the American Red Eye complex. The manufacturer believes that the Blowpipe complex is more effective than the American Red Eye complex or the Soviet Strela-2 MANPADS. The first export contract was signed with Canada in 1973. It is in service in Afghanistan, Argentina, Canada, Chile, Ecuador, and

Malaysia. The Thai Air Force has a modification of the Blowpipe MANPADS - LCNADS - a twin launch system with an optical sight that can be placed

on a light chassis or on the ground.

The Blowpipe missile can be used for integral equipment of the Javelin complex. Serial production has been completed.



TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum	3.5
minimum	0.7
Damage height, km: maximum	2.5
minimum	0.01
Length, m:	
missiles	1.35
missiles in TPK	1.4
Missile diameter, m	0.076
Weight, kg:	
missiles	11.0
missiles in TPK	14.5
sighting unit warhead	6.2
Maximum missile	2.2
speed, M Warhead type	about 1
	high-explosive fragmentation with contact and proximity fuses IR guidance,
Pointing method	then command along the line of sight (CLOS) portable, single-barrel
Launcher	with manual grip

"Javelin"

(GREAT BRITAIN)

MANPADS "Javelin" is designed to repel the impact of sh- a wide class of air attack weapons flying at low altitudes, as well as to protect friendly troops on the battlefield using a semi-automatic guidance system (SACLOS - Semi-Automatic Command to Line of Sight) that is more effective than the IR seeker. The engagement range of high-speed attack aircraft facilitates the destruction of these targets before the bombing line. The Javelin MANPADS can be used to destroy helicopters, and in extreme cases, to destroy ground targets.

In 1979, by order of the UK Ministry of Defense, the creation of a new Javelin MANPADS began by modernizing the Blowpipe MANPADS.

Serial production of the Javelin complex began in 1984, and in the middle of the same year the MANPADS were used by the Royal Navy of Great Britain to provide air defense for ships located in the Middle East from airborne targets such as

Mikaze."

Compared to the Blowpipe, the Javelin MANPADS has a new, larger warhead, as well as a more powerful rocket engine. Its high specific impulse explains

This is achieved by using new fuel, which makes it possible to increase the range of hitting targets. The shooter's work is greatly facilitated by the new semi-automatic guidance system. A new monocular sight for the Javelin MANPADS was created

was designed taking into account its use at the Blowpipe complex.

According to press reports, in the mid-90s, the Javelin MANPADS were replaced by the new Star-burst MANPADS. Now the Javelin complex is used in training

for certain purposes.

The Javelin MANPADS consists of a missile located in the GPC and sighting equipment. The container, factory-loaded with a missile, has minimal weight and is designed on the principle of reducing recoil when fired. It contains a trigger device, a battery for powering the rocket and an aiming device. The front cover of the container, made of plastic, breaks off under the pressure of gases generated when the engine starts. In addition to the Javelin MANPADS, a “friend or foe” identification system and a night sight can be attached.

The length of the rocket is 1.4 m. The warhead is located in the center of the rocket body. The guidance system equipment is located in the front of the hull, and the engine is in the tail. There are four delta-shaped wings located on a freely rotating ring in the nose of the rocket and four wings in the rear of the body. When the missile is placed in the TPK, the front wing consoles are folded and opened after it leaves the container. Thanks to the free rotation of the wings and their location at a certain angle to the longitudinal axis of the rocket, its aerodynamic stability in flight is ensured.

The sighting unit is located in its own container on the right side of the trigger mechanism. This container contains a stabilized sight, which provides manual target tracking, and a television camera, with the help of which semi-automatic guidance is carried out

missiles to target using the three-point method.

Commands from the television camera are digitally processed by a microprocessor and transmitted to the rocket via a radio link. The TPK has a fuse.

After connecting the sighting device to the container, the Javelin MANPADS is ready for combat use in less than 5 seconds. Information about the possibility of an air attack is received by the shooter via

a radio link via the warning network, or the target is detected independently when surveying the space. The shooter observes the target through a monocular sight and, when it reaches the far boundary of the launch zone, activates the trigger mechanism. The shooter must select the frequency at which the transmitter will send guidance commands to the missile. After pressing the trigger, two thermal batteries are launched, power is supplied to the aiming device and the rocket. After the pyrocharge is triggered, the gyroscope rotor spins up under the influence of the generated gases, and then the starting engine starts (runs 0.2 seconds before the rocket

takes off from the TPK). At a safe distance from the shooter, the main engine starts working, accelerating the rocket to a speed of Ml.6. In the absence or loss of guidance signals, the missile self-destructs. At this time, a round red

label

Unlike the Blowpipe complex in the Javelin MANPADS the guidance system automatically guides the missile along the line of sight zitting throughout the entire flight of the rocket. This is ensured with the help of a miniature television camera that receives radiation from flyers burning in the tail of the rocket. Marks from the target and the missile are displayed on the television camera screen, their coordinates are processed by a microprocessor computing device, and then control commands are transmitted to the missile. In the field of view of the optical sight

an aiming mark is projected, which the shooter, with the help of The joystick is aligned with the target. Detonation of a warhead carried out using contact or non-contact fuses. According to the manufacturer of the complex, its combat

effectiveness was demonstrated in 1985, when the 10th

The air defense system destroyed 8 Skeet-type targets with eight Javelin missiles. Serial production has been completed, more than 16,000 missiles have been produced. The Javelin MANPADS are in service with eight countries, including Canada, Jordan, South Korea, Oman, Peru, and Botswana. Shorts has created a multi-charge launcher LML (Lightweight Multiple Launcher), designed to destroy several targets. All LML systems use three standard Javelin missiles in a TIC mated to a standard sighting assembly. The multi-charge launcher is located on a tripod or placed on a chassis. .Is in service with the British Army.

TACTICAL AND TECHNICAL CHARACTERISTICS

Maximum damage range, km:	
aircraft	4.5
helicopters	5.5
Minimum damage range, km Height of damage,	0.3
km: maximum	
	3.0
minimum	0.01
Rocket length, m	1.39
Rocket diameter, m	0.07
Rocket wingspan, m Weight,	0.27
kg: missile	
warhead	12.7
	2.74.
explosives missiles in the	0.6
TPK missiles in	15.4
the TPK in the field conditions of the	19.0
sighting unit Field of	8.9
view of the TV camera, mm:	
wide	5.75x4.5
narrow	0.9x0.9
Maximum missile speed, M Power	about 1.6
sources	direct current (27.5-35.5 V) for the TPK and three rechargeable batteries for the sighting unit

Starburst (UK)

Shorts has been creating Starburst MANPADS since the mid-80s (original name Javelin S15). It is a variant of the Javelin MANPADS with improved mechanical protection.

Developed by order of the British Ministry of Defense, the MANPADS retained all the advantages of its predecessor. In addition, it has a laser optical guidance system created for the Starstreak system. This made it possible to increase the probability of hitting the target.

In 1986, the complex was adopted by the British Army, and the first deliveries were made at the same time. Operational deployment began in early 1990, when the Starburst replaced the Javelin MANPADS and entered service with regular and reserve army units.

In a simple configuration, the Starburst MANPADS consists of two parts: the missile in the TPC and the attached sighting device. However, a three-component system is mainly used. It was named LML (Lightweight Multiple

Launcher) - a lightweight multi-channel launcher that increased the firepower of the complex. Depending on the LML configuration, Starburst can be used as a ground-based, vehicle- or naval-based

option.

In 1994, it was announced that the Kuwaiti Ministry of Defense had decided to purchase the Starburst missile system, including Pilkington thermal imagers, allowing for day and night combat operations. The Starburst rocket is solid fuel, two-stage. The warhead is high-explosive fragmentation. There are two types of fuse:

contact and non-contact. Rocket control commands are received by a unit located in the head of the rocket. Ballistic stability is ensured by tail stabilizers, which house two laser transceivers for the guidance system. The latter act as repeaters between the guidance unit located in the head of the rocket and the control unit.

Each of the transceiver units includes a laser receiver, a signal processor and a transmitter, which are housed in a small cylindrical container. The reasons for having two electrically connected containers is to provide redundancy to the system to prevent any possible shielding effects.

The control command transceiver on board the missile is installed in the bow of the container. Optical detection data signals are received by small antennas connected to the control unit. It is a unit from the Javelin MANPADS with modified software.

The missile container is disposable and has a cylindrical shape. An electrical connector is placed on it so that signals from the trigger mechanism are supplied to the electrical circuits of the rocket. In the launch canister, the front cap is ejected by gas pressure when the rocket gyroscope

launched.

The sighting unit with dimensions 408x342x203 mm consists of a control system and a guidance system, which does not require adjustments and checks, has an optical stabilization

bathroom system, guidance command transmitter, six-fold monocular optical sight and manual tag input device. All this is in its own sealed

body made of light alloys.

The control unit consists of a lightweight housing containing a hermetically sealed compartment (with a wind compensation switch and electronic equipment necessary to process control information), an externally mounted battery and a manual control system, which includes a joystick, trigger, switch for selecting the type of fuse and push-button switch for selecting the height. In combat, when the artilleryman receives target designation, he locates the target using the sight and tracks it, moving the weapon so that the target coincides with the aiming device marker. At

This automatically calculates the lead angles in azimug and elevation. When the target enters the launch zone, the shooter activates the trigger mechanism. The missile flies out of the transport and launch container using the starting

engine, and the second stage of the propulsion system is launched at a safe distance from the shooter. The gunner continues to track the target, aligning the aiming point with the target using the joystick. Missile guidance commands are formed in exact accordance with the coordinates of the aiming device marker. Upon reaching the target, the missile warhead is detonated using a contact or non-contact fuse. If after the launch it is determined that the target is “your plane,” the shooter has the opportunity to

the ability to issue a command to the missile to self-destruct. •

A set of simulators has been developed for teaching calculations. Modifications of the complex: • “Starburst

LML” - a lightweight multi-channel

launcher (LML), similar to the LML “Javelin”. Uses three standard containers with Starburst missiles. It is equipped with aiming devices and, if necessary, identification equipment. LML weight 30.3 kg, maximum height 2.616 m, angle 45°, turning radius 0.927 m. • “Starburst VML” (Vehicle Multiple Launcher), mounted on the chassis of an all-terrain vehicle “Land”

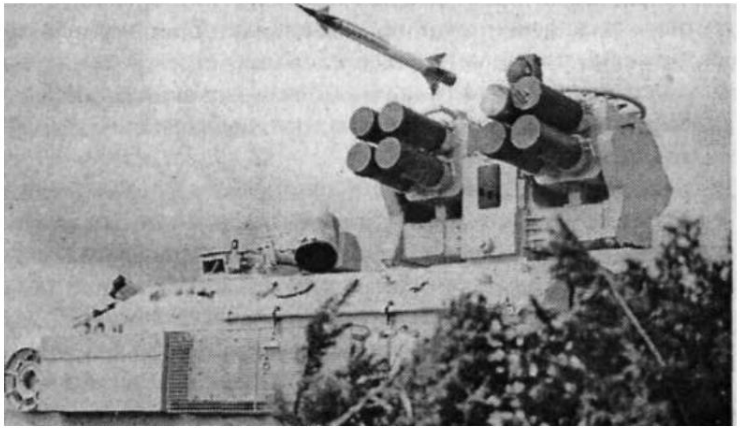
Rover (4x4), is a launcher similar in design to the Javelin, except that it uses three standard Starburst TPCs, as well as Starburst aiming and control devices.

The Starburst NML consists of a lightweight tubular launcher and two missile pods, each containing four operational Starburst missiles in a TPC. The launcher is controlled in angle and azimuth using electric drives. Optical and thermal imaging cameras are used to detect targets, which makes it possible to use

complex both day and night.

As a result of joint developments between Radamec Defense Systems and Shorts Missile Systems Ltd. a marine version of the complex was created, called “Starburst SR2000”. It combines a Starburst launcher with six missiles on a stabilized platform with a Radamec 2400 electro-optical tracking system. This creates a combined system with remote-controlled missiles and the Radamec 2400 detection system, which can track targets at ranges of more than 12 km, which

allows missiles to capture airplanes and helicopters at extreme ranges. The system can also affect anti-



Starburst air defense system on a tracked chassis

ship-borne missiles and can be used effectively against surface ships.

The Starburst self-propelled system can be placed on an armored tracked chassis MPZ (USA), AMX-10R (France). The launcher houses 8 missiles in the TPK. The rotating platform moves in angle and azimuth using electric drives. To detect and track targets, passive optical and thermal imaging cameras are used, which are integrated into a single unit. The thermal imaging camera allows for target detection at night.

Starburst has been upgraded since delivery to the armed forces. The Shorts company has developed and implemented a number of systems: the Thomson-CSF radar fuse is installed on the missile, which increases the damage radius of the high-explosive fragmentation warhead (tests of the improved fuse were carried out in 1991-1992); Rechargeable nickel-cadmium batteries have been replaced with non-rechargeable ones, which eliminates the need to have a large supply of batteries and a recharger; a removable night sight was installed (successful tests were carried out with the Simrad KN200 sight equipped with an image intensifier).

Starburst was used during Operation Desert Storm, where 10 batteries of the 40th Field Regiment Royal Artillery were deployed and remained 100% operational throughout the war.

The complex is in service with Great Britain, Kuwait, Malaysia and Canada.

TACTICAL AND TECHNICAL CHARACTERISTICS

Maximum destruction range, km Weight, kg:	< 4.0
missiles	
missiles	8.5
in TPK	15.2
warhead	2.74
Missile length, m	1.39
Wingspan, m Missile	0.19
speed, M	more than 1.0

"Starstreak"

(GREAT BRITAIN)

In December 1986, the UK Ministry of Defense entered into a contract with Shorts for the development and initial production of the Starstreak HVS high-velocity missile system in three versions: armored, portable launcher and single-tube.

A detailed analysis of existing and potential air attack weapons carried out by Shorts showed that the main threat to military units on the battlefield comes from supersonic air attack weapons and stealth attack helicopters. Thus, the high-speed missile (HVM - High Velocity Missile) was designed to destroy any target before the line of use.

calling her weapons.

Since 1982, after signing the contract, Shorts has performed more than 100 test launches of the high-speed rocket. The Starstreak MANPADS complements the British Rapier air defense system and, in comparison, requires less deployment time. There is conflicting information about the adoption of Starstreak MANPADS into service. According to some sources, the Starstreak complex is still under development. All three Starstreak variants use a basic model of the rocket, which is located in a transport and launch container. It has a two-stage solid propellant engine connected to the payload. In its capacity it is used

use three arrow-shaped spears placed in front
second stage of the engine. Each of them has its own control and guidance circuit. More than half the length and mass of the spear is made up of equipment, which includes an armor-piercing core and an explosive charge.

The sighting unit includes a light-alloy sealed optical sight with a stabilized laser system and a monocular sight (all of which are used to acquire and track the target), as well as a sealed control unit housed in a molded form that contains a power source (with one lithium sulfide battery) and electronic components necessary for data processing and control. The control unit has a joystick, a trigger mechanism, a general switch, a wind compensation switch and an altitude level meter.

During the battle, the gunner locks onto the target with his monocular sight and powers the sighting unit with a power source. The aiming mark is located in the center of the gunner's field of view, which keeps the selected target in the crosshairs of the sight. Guarantee in azimuth and elevation

states that the missile will destroy the target by hitting, including
including in the rear hemisphere.

After completing the pre-launch capture operations, the gunner presses the trigger. The starting accelerator is started from the power source. The rocket takes off from the TPK, and the launch engine is switched off. Accelerator

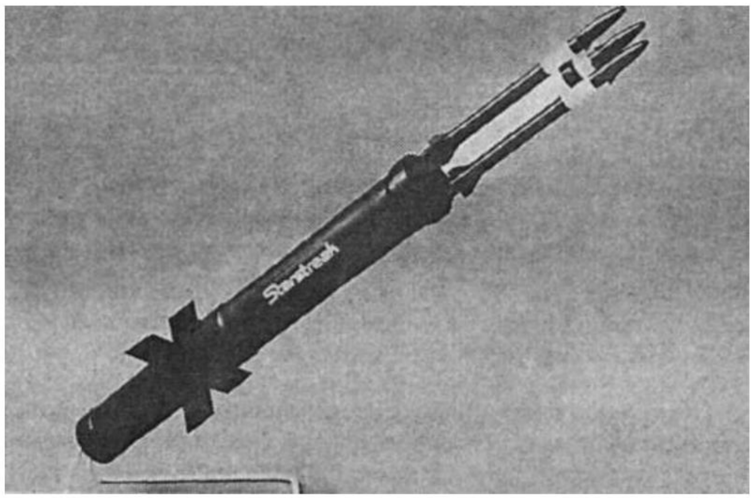
propels the rocket to high speed so that it has enough rotation to create a centrifugal force that deploys the stabilizers. The accelerator is separated from the rocket after it leaves the TPK at a safe distance from the shooter. After less than a second of flight, the main engine turns on and accelerates the rocket to speeds in the range from M3 to M4. After turning off the main engine

the pressure sensor automatically fires three shaped spears.

Arrow-shaped spears are aimed using a laser beam formed by an aiming unit using two laser diodes, one of which scans in the horizontal and the other in the vertical plane. The arrow-shaped spear has a length of 0.45 m and a diameter of 0.02 m, and has kinetic energy sufficient to penetrate

body of the target, and then explodes inside it, causing maximum damage. Over the entire flight range, arrow-shaped spears have sufficient maneuverability to destroy targets flying with an overload of up to 9g. After launch, the operator continues to align the target with the aiming mark using the joystick.

According to some data, the introduction of additional software



Rocket with three arrow-shaped spears

cookie allows you to hold the angle measuring device on target automatically.

After shooting is completed, the operator attaches a new one to the sighting unit instead of the empty TPK. The basic model of the Starstreak HVM rocket is a fair-weather system, provided the information

tion about the goal does not come from other sources, for example from THORN EMI Air Defense Alerting Device (ADAD), which was adopted by the British Army in 1987.

The modified lightweight multi-charge launcher consists of three standard Starstreak complexes arranged in a traffic light pattern (vertically). The portable sighting unit is mounted on a rotating device, which can quickly rotate 360 degrees. This

the system may be on the ground or located in trench

A modification of the Starstreak missile is the air-to-air missile Helstreak.

Multi-charge launcher

In September 1988, Shorts entered into an agreement to equip the AN-64 Apache helicopter with close-combat missile weapons. This system, called "Helstreak", consists of one or more twin on-board missile launchers (weighing 50 kg each) and a guidance system transmitter. The missile system is attached to the suspension using a standard 14-inch release mechanism. The Helstreak missile has been adapted to other helicopters.

In 1991, a version of the Starstreak complex was introduced for use on a marine multi-launch system. Two installations with three missiles each can be serviced from one workplace. The missile enters the British Army in a modification

mounted on a chassis.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum	7.0
minimum	0.3
Missile length in TPK, m	1.39
Missile diameter, m	0.12
Weight, kg:	
missiles in TPK	12.0
MANPADS in the combat	250
position of the warhead	2.74
explosive Maximum rocket	0.6
speed, M Engine type	about 4
	two-stage, solid fuel
	laser beam-guided
Guidance system	single-shot, portable
Launcher	
Probability of hitting a target with	
one missile	0.96
Combat crew, people.	2

FN-6
(CHINA)

The man-portable anti-aircraft missile system is designed to destroy airplanes and helicopters at low and extremely low altitudes. Firing at the target is carried out both on catch-up and on collision courses. The complex is manufactured by China National Precision Machinery Import & Export Corporation (CNPMIEC). It is assumed that the FN-6

complex is in service

Research Institute of the People's Liberation Army of China (PLA).

The two-stage solid-fuel rocket is made according to the canard aerodynamic configuration. It includes a thermal homing head, a steering compartment with flight control equipment, a high-explosive fragmentation warhead, and a two-stage propulsion system for ejecting the missile from the launch tube and ensuring flight to the target. Start-

The first engine is removed after the rocket leaves the launch tube, then the main engine is fired. The rocket has four stabilizers in the tail and four rudders in the front. Launch tube made of fiberglass, using

Suitable for storing, carrying, aiming and launching a missile. In the head part of the complex there is a cylinder with refrigerant for deep cooling of the heat receiver of the homing head and a power battery. The homing head has the shape of a pyramid, which houses an IR radiation detector with four cells. It is assumed that it is capable of guiding a missile when there is interference in the IR

range.

By special order, the MANPADS is equipped with an optical sight and “friend or foe” identification equipment. The sight and interrogator are mounted at the head of the complex.

Just like previous versions of MANPADS, this complex can be installed on tracked vehicles, helicopters, ships. One of the latest versions has four missiles with the operator located below deck level.

The FN-6 is capable of hitting a target performing a maneuver with an overload of up to 4g with a probability of at least 0.7.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum	5.0
minimum	0.5
Damage height, km:	
maximum	3.5
minimum Maximum	0.015
speed of targets hit, m/s: towards and after Probability of destruction	
Complex	300
mass, kg	360
Missile length, m Missile diameter,	0.7
m	16
	1.49
	0.07

"Strela-2"

(RUSSIA)

The Strela-2 man-portable anti-aircraft missile system (SA-7a “Grail” Mod.O according to the US/NATO classification) is designed to destroy low-altitude aircraft and helicopters at ranges of up to 4 km.

Work on the creation of the Strela-2 man-portable anti-aircraft missile system (MANPADS) began in 1960. By this time, limited information had been received that in the United States, back in 1958, the development of a man-portable air defense system with a missile equipped with a passive thermal homing head. Moreover, in the late 50s, American television showed a missile being fired at an air target from a launch tube on the shooter’s shoulder. This fact testified to the real possibility of creating portable anti-aircraft missile weapons. As you know, such a weapon was created in the USA in 1965 under the name “Red Eye”. The lead developer of the complex was the SKV GKOT design bureau. Chief designer B.I. Shavyrin. After his death in 1965, S.P. Invincible became the chief designer.

The development of requirements for the Strela-2 complex and its design took place through in-depth scientific research (at Research Institute-3 of the State Agrarian University) and the promotion of bold technical ideas in industry. The construction of a portable air defense system began with a “brainstorming”: B.I. Shavyrin and a group of specialists abandoned current affairs for two weeks and, during the exchange of ideas, formed the appearance of the future Strela-2 complex, and also developed proposals for -ektu TTT to the complex. Information about the complex later received from abroad

Red Eye confirmed the great similarity of the technical proposals for the creation of the Strela-2 portable air defense system with its foreign prototype. Designers from different countries, independently of each other, recognized the same technical solutions as the most appropriate.

The most important element of the missile defense system of the portable complex was the thermal homing head (TGSN), the development of which was entrusted to OKB-357 of the Leningrad Economic Council (later it became part of the Leningrad Optical-Mechanical Association - LOMO). The chief designer of the head was Pikkel, who was later replaced by O. A. Artamonov. A team of employees from the State Optical Institute (GOI) participated in the development of the thermal seeker. By that time, thermal seekers were already used in domestic

rocket technology. The main difficulty in developing a thermal seeker for the 9M32 missile defense system was the creation of a gyro-stabilization device (head coordinator) with small weight and size characteristics. A thermal seeker was created weighing no more than 1.2 kg in the dimensions required for the rocket. The guidance of the missile defense system was carried out using the proportional navigation method, which did not require large lateral overloads from the rocket.

The task of creating rocket propulsion systems also turned out to be difficult. Its launch was to be carried out from a launch tube from the shoulder of an anti-aircraft gunner from a standing position, from a kneeling position, from a trench. The complex was also supposed to allow missile launches from the hatches of armored vehicles moving at speeds of up to 20 km/h. It was necessary to prevent the anti-aircraft gunner from being hit by a jet of engine combustion products. A solution was found in the implementation of a scheme with the launch of the SAM sustainer engine at a safe distance for the shooter (using a specially designed pyrotechnic delay) after the SAM departs from the launch tube. The ejection of missiles from the tube was achieved by using an ejection charge that completely burned in the launch tube.

It was necessary to ensure the duration of work propulsion charge of the engine, commensurate with the flight time of the rocket. A very light missile defense system with a blunted fairing of the thermal seeker quickly slowed down after the engine stopped running. Taking into account the requirements for high maneuverability

Due to the lack of missile defense when aiming at a target, the passive part of its flight could be used only to a minimal extent. To remove the rocket achieved aerodynamic resistance tests in large extension and small diameter - 76 mm. After long-term testing, it was possible to create a mixed fuel charge with an increased combustion surface through the use of a crater-shaped end. The required burning rate (up to 40 mm/s) was achieved by reinforcing the charge with metal

metal wires for accelerated heating of the internal layers of fuel, ensuring their rapid ignition change.

To reduce the mass of aerodynamic rudders and steering gears, for the first time in the Soviet Union, a single-channel control system for a homing missile defense system was successfully used. The aerodynamic rudders on the missile defense system made according to the “duck” scheme were installed only in one plane, and the three-dimensional Control was achieved by rotating the rocket with appropriate conversion of signals from the thermal seeker to the rudders. For placing missile defense systems in a small diameter launch tube the rudders were recessed into the rocket body, and four feather stabilizers were placed in the space behind the nozzle exit. At the start, the rudders and stabilizers opened using spring devices. The small-sized missile defense system was

equipped with a light warhead (1.17 kg), capable of causing significant damage to the target only with a direct hit. When using a thermal seeker with low sensitivity, the missile was aimed in pursuit, so that the most likely case was approaching the target at small angles to its surface. Upon impact, the rocket was rapidly destroyed. Under these conditions, to effectively hit a target in a missile defense fusing device, a pulsed, highly sensitive magnetoelectric regenerator was used for the first time, in the circuit of which a semiconductor amplifier and reactive contacts were used, ensuring its timely action when hitting durable obstacles.

After state tests of the complex at the Donguz test site, the Strela-2 MANPADS was adopted in January 1968 for service.

The Strela-2 (9K32) portable air defense system consists of a 9M32 missile defense system located in a 9P54 launch tube (transport and launch container) with a power source docked to it, and a 9P53 launcher. The missile defense

system consists of the following main compartments:

• thermal seeker, designed to capture a target before launch, track it and generate commands for guidance

launching a missile at a target;

• steering compartment with flight control equipment; • warhead of high-explosive fragmentation-cumulative action of the penetrating type with a contact fuse device -

with two stages of protection and a mechanism self-destruction;

• a two-stage propulsion system designed to eject a rocket from the launch tube, give it rotation, accelerate to a speed of 430-450 m/s and maintain

niya it in flight.

The launch tube serves as a closure for the missile and provides aiming and launching of the missile defense system. Attached to the launch tube are a rotation unit for the thermal seeker gyroscope, a mechanical sight with a light signal indicating that the target has been captured by the homing head, an onboard connector mechanism, a shoulder strap for carrying, and a single-use power source that ensures launch preparation and launch of the rocket. The reusable triggering device (automation unit) includes an electronic unit, a starting mechanism, locking and coupling with the launch tube, as well as a buzzer. The electronic unit is necessary for spinning up the

thermal seeker's gyroscope, as well as for issuing information about the seeker's target acquisition by sounding a buzzer and lighting a light bulb. The combat operation of the Strela-2 portable air defense system occurs as follows. After visually detecting the target, the anti-aircraft gunner transfers the complex to the combat position and turns on the power source. After the homing head enters the operating mode and spins up the gyroscope rotor (about 5 seconds), it takes aim and upon receiving sound and light information about the capture of the target's thermal seeker,

by initially pressing the trigger, it releases tuning the gyroscope, as a result of which the head begins to track the target. By pressing the trigger all the way, the operator launches the rocket. At the same time, the engine ejecting the rocket is triggered, which pushes it out of the pipe at a speed of up to 30 m/s and imparts the required rotation. After leaving the tube, the rocket's rudders and stabilizers open. Then a signal is generated to turn the fuse into operating mode, the pyro-fuse is ignited and the first fuse protection stage is removed. 0.3 seconds after the rocket is released, the main engine starts. Then the second one is removed

the highest fuse protection stage, after which it is in a fully cocked state.

The rocket rotates in flight at an angular speed of 15 rpm, maintained by the corresponding tilt of the stabilizer installation plane.

When meeting a target, the explosive device detonates the warhead. In case of a miss, after 11-14 seconds the rocket self-destructor is activated. The Strela-2 complexes were used mainly

by anti-aircraft missile platoons, consisting of three squads of anti-aircraft gunners (according to the number of companies in the battalion). The squad of anti-aircraft gunners consisted of 3 people, each of whom had a launcher and two missiles (in the squad's transportable ammunition). One of the anti-aircraft gunners was the commander

director of the department.

Combat work was controlled by the squad commander. With the help of his small-sized portable radio station R-147, he received combat orders and target designation data from the air defense chief of the regiment,

carried out target distribution between the squad's riflemen and, using the same radio station, issued target designations in reference directions to riflemen with small-sized radio receivers (R-147P). In the absence of control from the air defense chief of the regiment, the squad commander is independent

carefully aimed the anti-aircraft gunners.

In 1968, the Stre-la-2 complex was modernized by the same developers. Tests of the modernized

portable air defense system, called Strela-2M (9K32M), were carried out from October 1969 to February 1970. The Strela-2M complex

(SA-7b "Grail" Mod.l) entered service in 1970.

With practically the same mass-dimensional characteristics of the complex's weapons, its combat capabilities were significantly improved.

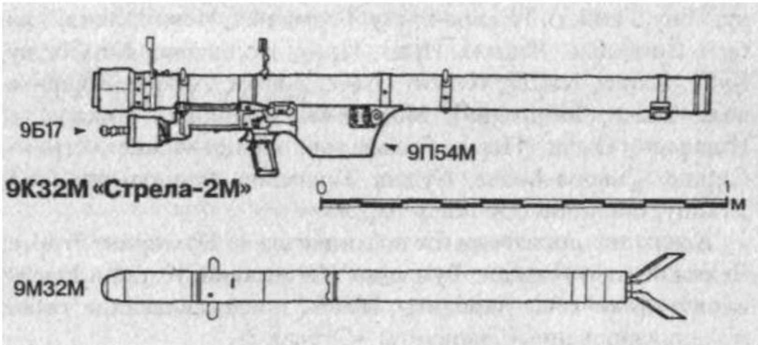
high and operational capabilities:

- the processes of target acquisition by the seeker and missile launch at high-speed air targets when firing on catch-up courses were automated, which facilitated the combat work of the anti-aircraft gunner, especially when firing from moving objects; • selection of a moving target was carried out in non-
moving natural interference;

- it is ensured that the shooter's error in the definition is eliminated near boundary of the launch zone;
- it became possible to hit targets flying at speeds of up to 260 m/s on catch-up courses; • shooting on collision
courses at helicopters is ensured
and aircraft with piston engines flying at speeds up to 150 m/s;

- the affected area on catch-up courses of jet aircraft has been increased (in altitude and range). The 9M32M rocket was
operated in the 9P54M launch tube. The newly developed 9P58 launcher had an increased number of contacts connecting to the launch tube and, accordingly, did not support the use of 9M32 missiles.

The noise immunity of the thermal seeker of the Strela-2M complex when operating against a cloudy background has improved. Firing was ensured when the target was located against the background of continuous (stratus), light (cirrus) and cumulus clouds of less than three points. However, with cumulus clouds illuminated by the sun of more than three points, especially in the spring-summer period, the range of the complex was significantly limited. The minimum angle in the sun at which it was possible to track air targets with the homing head was 22-43°. The horizon line on a sunny day also limited the affected area of the complex with an elevation angle greater than 2°. In other conditions, the horizon did not affect the shooting results. The complex was not protected from false thermal interference (heat traps fired by airplanes and helicopters).



Results of the combat use of Strela-2 MANPADS in Egypt, where the first production samples of the complex and a group of military technical specialists proved to be very effective. From July 1968 to June 1970, 99 missile launches were carried out. At the same time, 36 aircraft were damaged or shot down. In 1969, in one day of hostilities, ten missiles from the complex shot down 6 Israeli aircraft, while all other Egyptian air defense systems destroyed only 4 aircraft on the same day. In battles from October 6 to October 23, 1973, Arab anti-aircraft gunners, according to their data, shot down 23 Israeli aircraft, in battles from April 8 to May 30, 1973 - eight. The average efficiency of the complexes was 0.15–0.2. The military-economic damage caused to the enemy from the use of the Strela-2 portable air defense system was many times greater than the cost of the missiles expended.

Over the course of two months in 1974, Syrian air defense forces shot down 11 Israeli air targets. The complex was supplied to Vietnam to counter the American mass use of helicopters. In the period from 1972 to 1975. 589 launches of Strela-2 and Strela-2M missiles were carried out. At the same time, 204 hits were noted when the target was damaged or shot down.

The Strela-2 MANPADS were also used during the conflict in the Falkland Islands (by the Argentine Air Force), during the Iran-Iraq conflict, in Angola (MPLA and Cuban troops against South Africa), etc.

The complex was supplied to many countries of the world: Algeria, Afghanistan, Benin, Botswana, Burkina Faso, Hungary, Guyana, Ghana, Guinea, Guinea-Bissau, Germany, Yemen, Zaire, Zambia, Zimbabwe, India, Iran, Iraq , Jordan, Cambodia, Cuba, Qatar, North Korea, Kuwait, Laos, Lebanon, Libya, Mauritania, Mali, Mongolia, Mozambique, Namibia, Nicaragua, Nigeria, Oman, Peru, El Salvador, Seychelles, Syria, Sierra Leone, Sudan, Tanzania, Finland, Chad, Uganda, Ethiopia, South Africa. The complex was produced under license in: Bulgaria, Egypt, Czech Republic, China, Poland, Romania, Yugoslavia. China and Egypt produced their own versions of MANPADS, which were modernized versions of Strela-2.

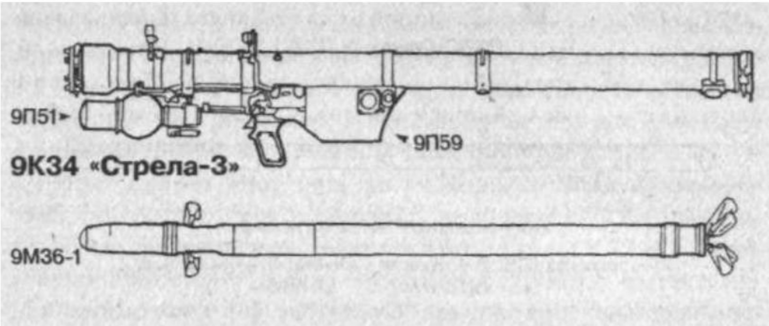
ПЗРК «Стрела-2» (9К32)

Компоновка ЗУР 9М32 «Стрела-2»:
1 – тепловая ГСН; 2 – рулевая машинка; 3 – боевая часть; 4 – взрыватель; 5 – двигатель.

TACTICAL AND TECHNICAL CHARACTERISTICS

	"Strela-2"	"Strela-2M"
Damage range, km:		
maximum	3.6	4.2
minimum	0.8	0.8
Damage height, km:		
maximum	2.0	2.3
minimum	0.05	0.05
Probability of hitting		0.11—0.24
Maximum speed of targets hit, m/s: towards		150
to catch	220	260
up Maximum speed of the missile, m/s Weight,	430	430
kg: missiles		
of the	9.15	9.6
warhead of the	1.17	1.17
combat equipment in the combat position Length,	15	
m:		
	1.44	1.43
MANPADS missiles in the combat position	1.49	1.'

"Strela-3"
(RUSSIA)



Man-portable anti-aircraft missile system 9K34 "Strela-3" (SA-14 “Gremlin” according to US/NATO classification) is intended chen for destroying airplanes and helicopters at ranges up to 4.5 km. The complex is capable of hitting targets on oncoming and catch-up courses.

The combat use of the Strela-2 complex showed that its effectiveness is insufficient. Many damaged aircraft returned to their bases and were put back into service after repairs that lasted only a few hours. This happened because the missiles hit the tail section of the aircraft, which contained few vital systems and assemblies, and the power of the missile defense warhead was insufficient to create a large destruction zone

goal designs.

The result of the further development of portable air defense systems of the Strela-2 and Strela-2M types was the Strela-3 complex, which has improved combat and technical characteristics and ensures combat against aircraft and helicopters flying on a collision course. with speeds up to 260 m/s and maneuvering with overloads up to 3g, as well as flying on catch-up courses at speeds up to 310 m/s and maneuvering with overloads up to 5-6g.

Among the new technical solutions and higher combat and operational characteristics of the complex are
Firstly, a fundamentally new thermal homing head with deep cooling to a temperature of -
200° C, providing sensitivity two orders of magnitude higher than the sensitivity of the seeker of the Strela-2M complex. This made it possible to fire on collision courses at aircraft and
helicopters, as well as significantly expand the affected area in height and parameters when firing on catch-up courses. Secondly, it was possible to ensure the functionality of the complex when firing on catch-up courses in any background situations. And thirdly, to develop a trigger mechanism that
made it possible to automatically launch a missile at a target located
extending in the launch zone, when firing on a collision course.

The Strela-3 complex was maximally unified with the Strela-2M complex, which simplified its serial production and adoption by the troops. The development of the Strela-3 (9K34) portable air defense
system with the 9M36 missile defense system began in 1968 simultaneously with the Strela-2M air defense system. The creation of a deep-cooled homing head was entrusted to a new co-contractor - the design bureau of the Kyiv plant "Ar-senal" (chief designer of the head I.K. Polosin).

Tests of this complex took place at the Donguz test site from November 1972 to May 1973. During the tests, errors associated with the insufficient reliability of the element base of the on-board equipment of the missile defense system were identified and eliminated. In 1974, the complex was put into service. During the tests, the following significant advantages of the Strela-3 portable air defense system compared to the Strela-2M complex were confirmed and identified:

- due to the use of a more sensitive thermal seeker in the missile, it was possible to fire at jet and turboprop aircraft on head-on courses at ranges up to 2500 m and at altitudes from 30 to 3000 m;
- the protection of the thermal seeker from background interference when firing on catch-up courses has been significantly increased;
- the shooting capabilities have been expanded in difficult weather conditions (rain, snow, fog) and in dusty air conditions (with visual visibility of the target).

The Strela-3 complex provides higher reliability of launching a rocket at a target with a jet engine at oncoming course due to the automatic detection of the capture and launch boundary of the launch zone based on radiation from the target. The external difference of the complex was the balloon located at the power supply under the

launch tube. The missile is aimed at the target using the pro- portional convergence.

The missile part of the complex was almost completely borrowed from the Strela-2M missile defense system. The

man-portable anti-aircraft missile system includes combat equipment, including a 9P59 launch tube with a 9P58M launch mechanism and a 9M36 anti-aircraft guided missile, a target detection means - a 9S13 passive radio direction finder, an identification means - a ground-based radar interrogator 1RL247, a communication means - radio station R-147 for the squad leader and receiver R-147P for

anti-aircraft gunners.

To check the technical condition and parameters of anti-aircraft missiles and the launching device, maintenance equipment is used, including a set of inspection and testing equipment 9F387.

For the training of anti-aircraft gunners, educational and training facilities are used, including a field simulator for anti-aircraft gunners 9F620M, a training and practical set 9F629, a launch control set 9F631.

The 9M36 missile defense system is made according to the canard aerodynamic design and consists of four compartments fastened together - the head, steering, combat and propulsion systems.

Aerodynamic control surfaces are installed in the same plane, and three-dimensional control is achieved by rotating the rocket at a speed of 15-20 revolutions per second with appropriate conversion of signals from the thermal seeker to the rudders. To place the missile defense system in a small-diameter launch tube, the rudders are recessed into the rocket body, and four feather stabilizers are placed in the space behind the nozzle exit. At the start, the steering wheels and stabilizers are opened by spring devices.

The head compartment of the missile houses a tracking target coordinator, a command generation device, and an electronic part

(autopilot amplifier), gyroscope rotor speed stabilization system, photodetector cooling system.

The tracking target coordinator (STC) is intended for non- continuous automatic determination of the mismatch angle between the optical axis of the coordinator and the “missile-target” line, tracking the target and generating a signal proportional to the angular velocity of the “missile-target” line of sight, the SCC consists of a target coordinator and an electronic unit.

The steering compartment is designed to accommodate elements power supply of the rocket, autopilot and switching elements cops. The steering compartment housing contains a powder pressure accumulator (PAA), which supplies power to the hot gases of the steering gear, and a turbogenerator, which converts the energy of the hot gases of the PPA into electricity, a stabilizer-rectifier, which provides rectification and stabilization of supply voltages, and a sensor angular velocities with an amplifier, a steering engine with rudders, a cocking unit that generates a signal to the electric igniter of the fuse after opening the rudders to the electric igniter of the powder control motor (PUD), a board connector socket that provides electrical connection between the on-board equipment of the rocket and the launch tube.

The combat compartment is the load-bearing compartment of the rocket and is made in the form of an integral connection, including the combat part and fuse.

The high-explosive fragmentation-cumulative warhead is designed to destroy air targets and consists of a body with a cumulative funnel, a combat (explosive) charge and a detonator.

The fuse is designed to issue a detonation pulse to detonate the warhead when the missile meets the target or after the self-destruction time has elapsed. The fuse consists of a safety-detonating device, a self- destruction mechanism, a charging capacitor, a contact target sensor (magnetic induction generator), an electric starting igniter, a double-action electric detonator, a fuse detonator and two contact groups.

The safety-detonating device serves to ensure safety in handling the missile until

its cocking after the missile launch. It includes a pyrotechnic fuse, a rotating sleeve and a blocking (inertia) stopper. The propulsion system is a starting and single-

chamber dual-mode solid fuel propulsion engine. The starting engine ensures that the rocket is ejected from the launch tube to a safe distance for the anti-aircraft gunner - *5.5* m, after which the main engine is started. The speed of the rocket's departure from the pipe is 28 m/s. The main engine accelerates the rocket to a speed of 470 m/s and

maintaining speed in flight.

The 9P59 launch tube is made of fiberglass and pre-

designated for storing the missile, aiming

tion and launch of the rocket. It can withstand up to 5 launches. The

9P58M launch mechanism is used to prepare for launch and safe launch of the rocket. Its body contains an electronic unit, a telephone, a locking device, a connector plug, a trigger and a contact group. The phone produces a sound signal when the target is in the field of view of the TGSN. The electronic unit is designed to accelerate the rotor of the TGSN gyroscope, automatically lock and unlock the gyroscope, process and evaluate information signals and correct them coming from the TGSN, issue sound and light information signals if there is a target in the field of view of the TGSN, and transmit voltages to starting devices. The passive direction finder (PDF) 9S13 ("Poisk") is designed for early detection of air targets flying with on-board pulse radar stations turned

on. The PRP is capable of detecting air targets at ranges of at least 12 km in the 50x45° sector.

NRZ S2 1RL247 is designed to identify the state affiliation of a target on the principle of "friend or foe" in the identification systems "Silicon-2", "Silicon-2M", "Password" in the third frequency range. Target identification can be carried out at ranges of 7-8 km at altitudes up to 5 km, identification time is no more than 3 seconds.

NRZ 1RL247 does not have a functional connection with the trigger mechanism and, in the event of a target response "I am mine," is not capable of automatically blocking the launch.

The R-147 radio station and the R-147P radio receiver are designed to receive air traffic alerts and fire control for anti-aircraft gunners. The radio station operates in the range of 44-52 MHz and provides a warning range of up to 1 km. The complex was supplied to the following countries: Angola,

Hungary, Vietnam, East Germany, El Salvador, India, Iraq, Jordan, Cuba, Libya, Nicaragua, North Korea, Peru, Poland, Syria, UAE, Slovakia, Finland, Czechoslovakia, South Africa, Yugoslavia.

Produced in Poland under license.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum	4.5
minimum	0.5
Damage height, km:	
maximum	3.0
minimum	0.015
Probability of destruction	0.31—0.33
Missile length, m	1.47
Maximum speed of targets hit, m/s:	
towards	260
catch	310
up Weight,	
kg: combat equipment in combat position	
missile	16
launcher without missile warhead	10.3
1.17 2.5 passive radio direction	2.95

finder NRZ 2.3 Self-destruction time, s 14-17 Operating temperature range, 'C -38 - +50 Average missile flight speed, m/s 470 MANPADS length in combat position, m 1.5 Time to transfer MANPADS to combat position, s 12

"Igla-1", "Igla"

(RUSSIA)

Man-portable anti-aircraft missile system 9K38 "Igla" (SA-18 "Grouse" according to US/NATO classification) is intended chen for destroying airplanes and helicopters at short ranges altitudes and altitudes. The complex is capable of hitting both maneuvering and non-maneuvering targets on collision courses and catch up

The development of the complex began in 1971 at the KBM (Design Bureau of Mechanical Engineering) in Kolomna, chief designer S.P. Nepobedimy. The developers were faced with the task of significantly increasing the effectiveness of the combat use of MANPADS in conditions of the use of enemy

com IR traps, increasing the firing range at targets on collision courses, more reliable determination of the nationality (identification) of the target, as well as

preliminary targeting of anti-aircraft gunners at the target nearby enemy planes and helicopters as air defense control points at the tactical level.

In order to ensure the accelerated equipping of ground forces with highly effective weapons, simultaneously with the continued development of the Igla complex, work began on the creation of a simplified portable air defense system Igla-1.

(SA-16 "Gimlet") using a modified thermal seeker from the Strela-3 missile in the missile defense system. Tests of the 9K310 Igla-1 MANPADS were carried out from January 15 to July 9, 1980. The complex was put into service in March 1981.

Compared to the Strela-3 portable air defense system, the probability of hitting an F-4 fighter flying at a speed of 310 m/s with one missile when firing towards it increased from 0.09 to 0.59, in pursuit (at a target speed of 260 m/s). c) - from 0.07 to 0.44. The maximum speeds of targets hit increased from 310 to 360 m/s when firing towards, from 260 to 320 m/s when firing after. The upper limit of the affected area increased from 2200 to 2500 m.

To improve the dynamics of missile guidance to the pre-emptive meeting point with the target, an additional circuit was introduced into the thermal seeker, which generates a command for turning the missile at the initial phase of the flight, and an electronic "catch-up" mode switch. To ensure post-launch turn, mini-sizes were installed in the steering compartment of the rocket.

innovative pulsed solid propellant engines.

The missile is aimed at the target using the proportional approach method.

Serial production of combat weapons of the 9K310 complex was carried out at the Kovrov plant named after. V. A. Degtyareva.

MANPADS "Igla-1" consists of combat equipment (launch tube 9P322 with trigger mechanism 9P519-1 and anti-aircraft guided missile 9M313), identification and target designation means (portable electronic tablet 1L15-1 and ground-based radar interrogator 1L14-1) , communications equipment (radio station R-157 and receiver R-157P).

To check the technical condition and parameters of anti-aircraft missiles and the launching device, maintenance equipment is used, including a mobile control point 9V886 and a set of test equipment for bases and arsenals 9F387M. For the training of anti-aircraft gunners, educational and training facilities are used,

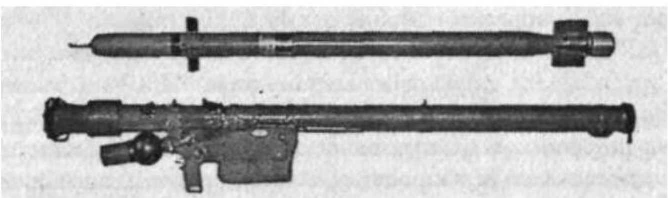
including a field simulator for anti-aircraft gunners 9F634, a training and practical set 9F634, a launch control set. The 9M313 missile defense system is made according to the canard aerodynamic design and is a cylindrical body with a spherical

fairing. To reduce aerodynamic drag, a small conical fairing was placed in front of the thermal seeker, mounted on three inclined rods, forming a kind of “tripod”.

The missile consists of four compartments fastened together - the head, steering, combat and propulsion systems. The rocket rests on the inner walls of the tube with centering belts that determine the caliber.

The head compartment of the missiles houses a tracking target coordinator (STC), a command generation device (CDD), an electronic part (amplifier) of the autopilot, a gyroscope rotor speed stabilization system, and a photodetector cooling system. A photoresistor based on

indium antimonide, cooled to a temperature of -200° C, is used as a photodetector , the maximum spectral sensitivity of which lies in the range of 3.5-5 microns. Compressed nitrogen is used to cool these photoresistors. Deep cooling of the photoresistor made it possible to increase the sensitivity of the TGSN to the radiation of the gas jet of a jet engine and reduce the sensitivity to reflected solar energy.



Man-portable anti-aircraft missile system "Igla"

The steering compartment is designed to accommodate elements power supply of the rocket, autopilot and switching elements. The steering compartment housing contains a powder pressure accumulator (PAA), which supplies power to the hot gases of the steering gear, and a turbogenerator, which converts the energy of the hot gases of the PPA into electricity, a stabilizer-rectifier, which provides rectification and stabilization of supply voltages, and a sensor angular velocities with an amplifier, a steering machine with rudders, a cocking unit that generates a signal to the electric igniter of the fuse after opening the rudders and to the electric igniter of the powder control motor, a board connector socket that provides electrical connection between the on-board equipment of the rocket and the launch tube .

The rocket has a powder control engine that produces hot gases for gas-dynamic control of the rocket's flight in the initial phase. The combat compartment is the load-bearing compartment of the

rocket and is made in the form of an integral connection, including a warhead, a fuse, and an explosive generator.

The high-explosive fragmentation-cumulative warhead is designed to destroy air targets and consists of a body with a cumulative funnel, a combat (explosive) charge and a detonator. The warhead uses an explosive with increased high-explosive action.

The fuse is designed to issue a detonation pulse to detonate the warhead when the missile meets the target or after the self-destruction time has elapsed. The fuse, in addition, ensures the transfer of the detonation pulse from the warhead charge to the charge of the explosive generator.

The safety-detonating device serves to ensure safety in handling the missile until it is cocked after the missile is launched. It includes a pyrotechnic fuse, a rotating sleeve and a blocking (inertia) stopper. The explosive generator is designed to create a detonation pulse to detonate the fuel charge of the

propulsion system and create an additional destruction field.

The tube is designed for aiming, launching a rocket and

protecting the anti-aircraft gunner from the effects of powder gases from the starting engine during startup. At the same time, it serves as a capping for the rocket during carrying, transportation and storage, as well as a guide during rocket launch. During operation, the rocket is not removed from the tube and leaves the tube only during launch. The pipe is made of fiberglass. It consists of: a rotation unit, a mechanical sight, a side connector mechanism, a socket for joints

trigger mechanism, zonal connection block
starting engine chains, shoulder belt mounting clip. The rotation block is attached to the front part of the pipe and, together with the acceleration and synchronization block of the starting mechanism, is designed to accelerate the rotor of the TGSN gyroscope. The antennas of the ground radio interrogator are installed on the pipe rotation unit. Since pipes are reusable, the

number of red stripes applied to the block

sensors, indicates the number of missile launches made from a given tube.

The mechanical sight consists of folding front and rear posts and is designed for aiming. A front sight with a hole is attached to the front post. On the rear pillar there is a rear sight with a light information lamp, the lighting of which indicates that the target radiation is entering the field of view of the TGSN, and a diaphragm that closes the lamp during launches at dusk to avoid blinding the shooter.

ka-anti-aircraft gunner.

The front and rear sections of the pipe are closed with easily removable covers. The front cover contains a magnetic circuit (a metal ring), which serves as a lock for the rotor magnet. The launch mechanism is designed to prepare for launch and launch the rocket. The 1L14-1

interrogator is built into the trigger mechanism, providing target identification and automatic blocking of the launch of missiles on its own aircraft. However, due to the large width of the antenna radiation pattern, as well as the presence of the rear lobes of this pattern, the interrogator can be triggered by the transponder of its aircraft flying near a portable air defense system and block the missile launch at the enemy. In such cases, the shooter can disable the launch lock.

Portable electronic tablet 1L15-1 is designed

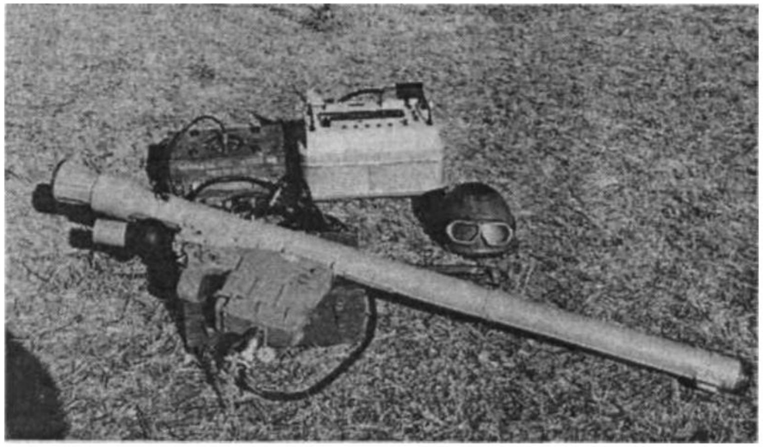
for timely notification of anti-aircraft gunners about the month
those locations, direction of movement and state affiliation
("friend or foe") air targets. The tablet is capable of displaying air conditions within a radius of 12.8 km. The number of simultaneously displayed targets is 4, the maximum distance to the information transmission point is 15 km. The source of information for the tablet can be air defense control points at the division-regiment link. Modifications "Igla-IE" and "Igla-1M" were produced, which differed in that the remaining fuel was not destroyed when the warhead was detonated. In addition, the Igla-1M did not have a radar

interrogator, while the Igla-IE had an interrogator with parameters determined by the customer country.

In 1982, tests were carried out on the Igla complex, which was put into service in 1983. The MANPADS is a further development of the Igla-1 complex and differs

from the latter in increased efficiency due to the use of a two-channel homing head 9E410, developed by LOMO JSC (chief designer of the head O. A. Artamonov). The homing head is capable of distinguishing

true and false goals in conditions of setting artificial
significant interference in the infrared range. The seeker has increased sensitivity, which increases the firing range at
targets on collision courses.



Igla MANPADS kit

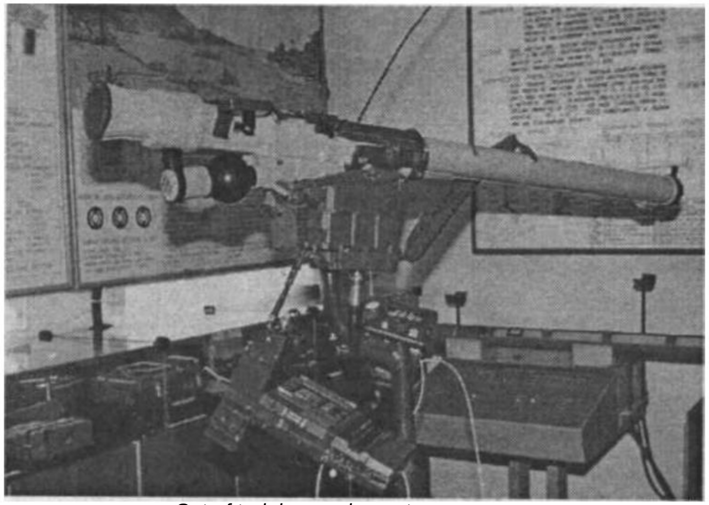
The 9E410 thermal homing head has two channels - the main and auxiliary.

The photodetector of the main channel is a fo-
a toresistor based on indium antimony, cooled to a temperature of -200 ° C. The cooling system of the photodetector is the same as that of Igla-1. The maximum spectral sensitivity of the main channel photodetector lies in the range of 3.5-5 ÿm, which corresponds to the spectral radiation density of the gas jet of a jet engine.

The photodetector of the auxiliary channel is an uncooled photoresistor based on lead sulphide, the maximum spectral sensitivity of which lies in the range of 1.8-3 microns, which corresponds to the spectral radiation density of interference such as false thermal targets.

The 9E410 seeker switching circuit makes a decision according to the rule: if the signal level of the photodetector of the main channel is greater than the signal level of the auxiliary channel, then this is a target, if on the contrary - interference.

The use of a new thermal seeker made it possible to use
to reduce aerodynamic drag, not the “tripod” used on the Igla-1 missile, but an elegant needle-like design.



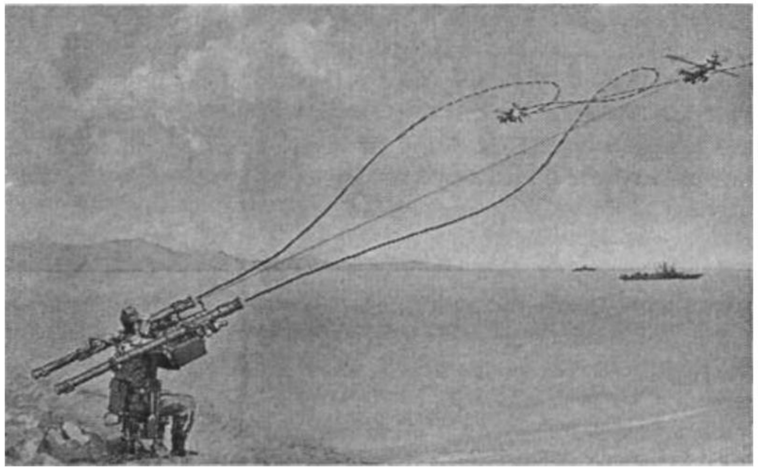
Set of training equipment

The complex ensures the destruction of air targets at
oncoming and catch-up courses, firing at time intervals of 0.3 s or more thermal interference with the total radiation power exceeding the target radiation power up to six times. When shooting thermal interference targets on oncoming and catching courses, singly or in salvos (up to six pieces in a salvo), the average probability of hitting a target with one 9M39 missile defense system per flight of the affected area was 0.31 when firing towards and 0.24 when firing after. In such interference conditions, the Igla-1 complex was practically inoperable.

Later, mainly for the Airborne Forces, a version of the portable air defense system “Igla-D” was developed with a missile defense system and a launch tube, which was transported in the form of two sections connected before combat use. This made it possible to improve the “landing capability” of the complex and ensure its ease of portability.

A unit was also developed that ensures the use of two missiles in launch tubes for use in ground-based
launchers and as weapons for helicopters in the Igla-V complex.

Twin support-launcher "Dzhigit"



Missile launch from the Dzhigit installation

To ensure the simultaneous use of two missiles, a version of the complex with a turret ("Dzhigit") has been developed, in which the anti-aircraft gunner is placed in a rotating chair and manually aims the launcher at the target.

In addition, a version of the Ig-la-N portable air defense system with a more powerful warhead was developed. The mass of the complex increased by 2.5 kg. Due to a slight reduction in such indicators as the speed of targets hit on oncoming and catch-up courses (up to 340 and 280 m/s, respectively), the probability of hitting targets is increased by 25-50%.

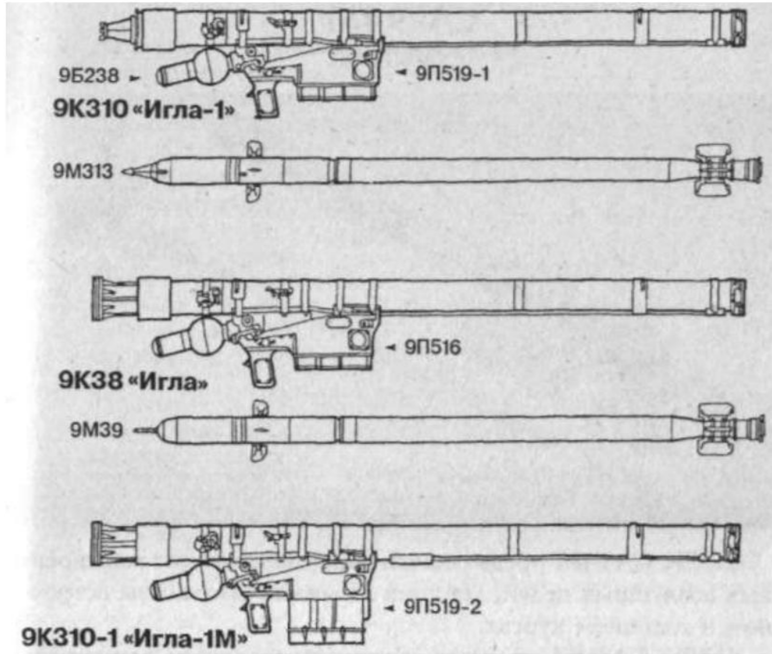
The Igla-1 portable air defense system was exported abroad, changed in local hostilities.

According to published data, most of the aviation losses of the multinational forces in the 1991 war were associated with the use of man-portable air defense systems by the Iraqis. In particular, they shot down four AV-8B Harrier vertical take-off and landing aircraft. The complex was supplied to the following countries: Angola, Bulgaria,

Botswana, Hungary, Vietnam, India, Iraq, North Korea, Cuba, Libya, Nicaragua, UAE, Peru, Rwanda, Saudi Arabia, Syria, Slovakia, Finland, Ethiopia, South

Slavia.

In Bulgaria and the DPRK it is produced under license.

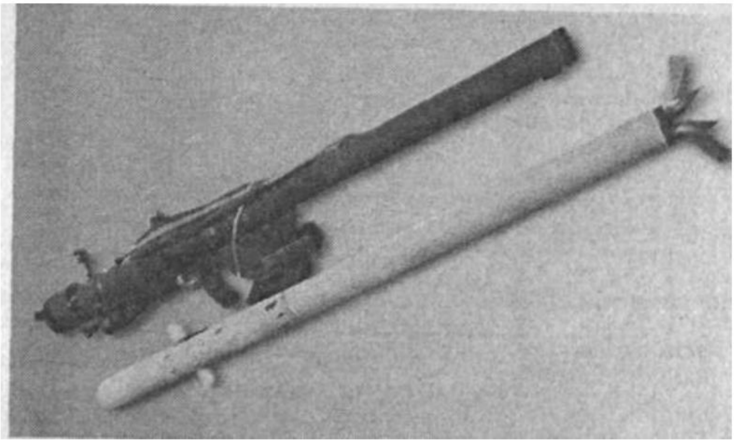


TACTICAL AND TECHNICAL CHARACTERISTICS

	"Igla-1"	"Igla"	"Igla-D"	"Igla-N"
Damage range, km:				
maximum			5.5	
minimum	5 0.5	5 0.5	0.5	5 0.5
Damage height, km:				
maximum	3.5	3.5	3.5	
minimum	0.01	0.01	0.01	3 0.01
Chance of defeat:				
airplane	0.4—0.5 0.4—0.5 0.4—0.5 0.5—0.6 0.3—0.4 0.3			
helicopter	—.4 0.45—0.6 0, 3 0.3 0.6—0.7 0.37			
cruise missile in conditions of interference		0.37		
Weight, kg: combat vehicles in the combat	17	17.0	17.3	19.5
position of the warhead	1.27	1.27	1.27	3.5
MANPADS length, m: in combat position	1.7	1.7	1.75	1.87
in a stowed position	1.7	1.7	1.1	1.1
Time to transfer MANPADS to combat position, s	13	13	60	60

SA-94M

(ROMANIA)



MANPADS SA-94M is designed to destroy maneuverable air targets flying at low altitudes in oncoming
nom and catch-up courses.

The SA-94M MANPADS is a modernized version of the SA-94 MANPADS, in which electronic equipment made using modern technology, a power source with a short ramp-up time, and

system for indicating the lead angle entered by the shooter when opening fire.

As a result of the modernization of MANPADS, the probability of hitting a target with a missile and the reliability of pre-launch operations have increased, the accuracy of missile guidance at the target has increased, and the firing capabilities have improved in day and night conditions. The basis of the SA-94M MANPADS is the combat system and the maintenance

and training system. The combat system includes the A-94M missile in a transport and launch container, a power source and a lead angle indication system.

Denia.

The maintenance and training system includes an upgraded technical verification system for the complex (IV-94M) and a field training kit (IA.C-94).

TACTICAL AND TECHNICAL CHARACTERISTICS

Maximum damage range, km:	
on a collision course on a	3.3
catch-up course	4 5
Minimum damage range, km:	
on a collision course on a	0.5
catch-up course Damage	0.6
height, km:	
maximum	2.3
minimum Maximum	0.03
rocket speed, m/s:	
on a head-on course on a	260
catch-up course Time to	310
reach power source mode, s Type	
of warhead Type of fuses	1.3
System for introducing	fragmentation type
the lead angle	contact and non-contact
	manual, with an autonomous indicator of the lead angle and direction

"Stinger"

(USA)

The man-portable anti-aircraft missile system is designed to destroy aircraft (including supersonic) and helicopters.
years flying at low and extremely low
altitudes. Firing can be carried out both on catch-up and on collision courses. The development of the complex by General Dynamics began in 1972. The basis was the work carried out under the ASDP (Advanced Seeker Development) program, which began in the late 60s shortly before the start of mass production of the Red Eye MANPADS. The development was completed in 1978, when the company began production of the first batch of samples, tests of which were carried out in 1979-1980. Since 1981, the complex has been produced in series and supplied to the ground forces of the United States and various European countries. MANPADS consists of a missile defense system in a transport and launch container (TPC), an optical

sight for visual detection and tracking of an air target, as well as an approximate determination of the range to it, a trigger mechanism, a power supply and cooling unit with an electric battery and a capacity with liquid argon, identification equipment for "friends and foes"

joi" AN/PPX-1. The electronic unit of the latter is carried behind
anti-aircraft gunner's belt.

The rocket is made according to the canard aerodynamic design. In the bow there are four aerodynamic surfaces, two of which are rudders, and the other two remain stationary relative to the missile defense body. To control using one pair of aerodynamic rudders, the rocket rotates about its longitudinal axis, and the control signals received by the rudders are consistent with its movement relative to this axis. The rocket acquires its initial rotation due to the inclined location of the launch accelerator nozzles relative to the body. To maintain the rotation of the missile defense system in flight, the planes of the tail stabilizer are installed at a certain angle to its body. Controlling the flight of missiles using one pair of rudders made it possible to

significantly reduce the weight and cost of flight control equipment. The rocket's solid propellant propulsion engine accelerates it to a speed equal to M2.2. Turning on the engine
occurs after separation of the launch accelerator and removal of the rocket from the shooter at a distance of about 8 m.

The combat equipment of the missile defense system consists of a high-explosive fragmentation warhead, an impact-type fuse and a safety-actuating mechanism that ensures the removal of the fuse safety stages and the issuance of a self-propelled command.
vision in case of a missile miss.

The missile is housed in a cylindrical sealed transport and launch container made of fiberglass. The ends of the container are closed with lids that collapse when the rocket is launched. The front one is made of material that transmits ultraviolet and infrared radiation, which allows the seeker to lock onto a target without destroying the seal. The tightness of the TPK allows missiles to be stored without maintenance or inspection for 10 years.

To date, three modifications of MANPADS have been developed: "Stinger" (basic), "Stinger" POST (POST - Passive Optical Seeket Technology) and "Stinger-RMP" (RMP - Reprogrammable Micro Processor). Modifications differ in the types of sanitary heads
guidance used on anti-aircraft guided missiles PM-92 modifications A, B and C, respectively.

The trigger mechanism, which is used to prepare and launch the rocket, is connected to the TPK with special locks. The electric battery of the power supply and cooling unit is connected to the rocket's on-board network through a plug connector, and the container with liquid argon is connected to the cooling system through a fitting. On the lower surface of the starting mechanism -
At the bottom there is a connector for connecting identification equipment, and on the handle there is a trigger with one neutral and two working positions. When it is moved to the first operating position, the power supply unit is activated and
cooling, the gyroscopes are spinning up and the rocket is being prepared for launch. In the second position, the on-board electric battery is activated and the igniter of the missile launcher starting engine is fired.

Stinger MANPADS simulator

The FIM-92A missile is equipped with an IR seeker operating in the range of 4.1-4.4 microns. The FIM-92B missile seeker operates in the IR and UV ranges. Unlike the FIM-92A, where information about the target's position relative to its optical axis is extracted from a signal modulated by a rotating raster, it uses a rasterless target coordinator. Its IR and UV radiation detectors, operating in the same circuit with two microprocessors, allow rosette-shaped scanning, which, according to the foreign press, provides high target selection capabilities in conditions of background interference, as well as protection against countermeasures in IR -range. Production of the rocket began in 1983.

The FIM-92C missile, the development of which was completed in 1987, uses the POST RMP seeker with a reprogrammable microprocessor, which ensures that the characteristics of the guidance system are adapted to the target and jamming environment by selecting appropriate programs. Replaceable memory blocks in which standard programs are stored are installed in the body of the MANPADS trigger mechanism.

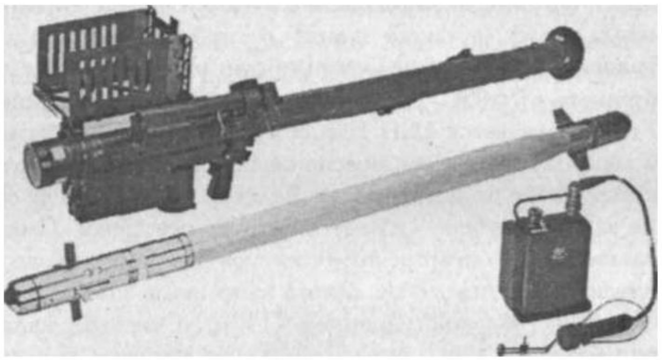
The main firing unit of the Stinger MANPADS is
a crew consisting of a commander and a gunner-operator, at whose disposal are six missiles in the TPK, an electronic warning and display unit for the air situation, as well as an M998 Hummer all-terrain vehicle. Since the fall of 1986, the complex was used by the Mujahideen in Afghanistan, when
(according to foreign press reports) more than 250 planes and helicopters were destroyed. Despite the poor training of the Mujahideen, more than 80% of the launches were

successful.

In 1986-87 France and Chad carried out a limited number of Stinger launches against the Libyan aircraft. British forces used a small number of Stingers during the Falklands conflict in 1982 and shot down an Argentine IA58A Pucara attack aircraft.

MANPADS "Stinger" of various modifications were supplied to the following countries: Afghanistan (Mujahideen partisan formations) - FIM-92A, Algeria - FIM-92A, Angola
(UNITA) - FIM-92A, Bahrain - FIM-92A, UK -
FIM-92C, Germany - FIM-92A/C, Denmark - FIM-92A, Egypt -

FIM-92A, Israel - FIM-92C, Iran - FIM-92A, Italy - FIM-92A, Greece - FIM-92A/C, Kuwait - FIM-92A/C, Netherlands - FIM-92A/C, Qatar - FIM-92A, Pakistan - FIM-92A, Saudi Arabia - FIM-92A/C , USA - FIM-92A/B/C/D, Taiwan - FIM-92C, Turkey - FIM-92A/C, France - FIM-92A, Switzerland - FIM-92C, Chad - FIM-92A, Chechnya - FIM-92A, Croatia - FIM-92A, South Korea - FIM-92A, Japan - FIM-92A.



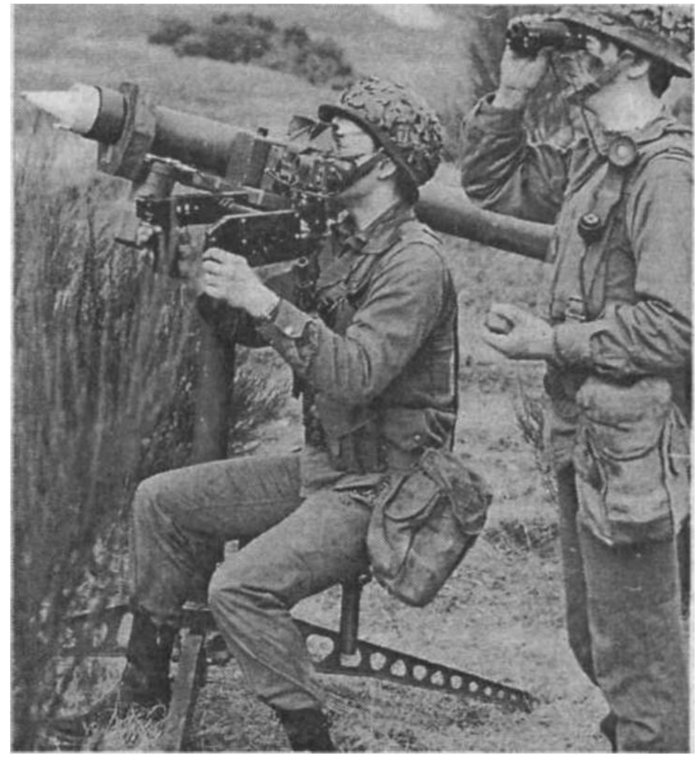
MANPADS "Stinger" with a missile and an electronic identification system unit

TACTICAL AND TECHNICAL CHARACTERISTICS

	FIM-92A	FIM-92B	FIM-92C
Damage range, km: maximum		4.8	4.8
minimum	4 0.5	0.5	0.5
Damage height, km:			
maximum	3.5	3.8	3.8
minimum	level land	level land	level land
Weight, kg:			
missiles	10.1	10.1	10.1
missiles in TPK	13.3	13.3	13.3
MANPADS complete with warhead	15.7	15.7	15.7
interrogator	3	3	3
Missile length, m	2.6	2.6	2.6
Missile diameter, m	1.52	1.52	1.52
Wingspan, m	0.07 0.09	0.07 0.09	0.07 0.09

"Mistral"

(FRANCE)



Testing of the Mistral MANPADS began in 1983. The last of the 37 planned was completed in March 1988. The first samples of the Mistral MANPADS were delivered to the French army and air force at the end of 1988.

Currently, this complex is located in three air defense buildings. Each has batteries consisting of 4-6 sections with six MANPADS and a Thomson -CSF-Samanta warning system.

All sections are located at the vertices of the triangle, with a pair of launchers at a distance of 2.5 km from other pairs. It is known that the 4th Airmobile, 11th Parachute and 27th Alpine Rapid Reaction Divisions have their own

portable portable air defense systems. The other two rapid response divisions (6th and 9th Marines) each have a battery of SANTAL mobile air defense systems. The French Air Force uses these MANPADS to protect its airfields. During the Gulf War, all French units had Mistral MANPADS.

The Mistral MANPADS includes a missile in a TPK, a tripod with an aiming device (with the ability to move in an elevation plane), a friend-or-foe interrogator and a power source. The sighting device consists of a collimator and optical sights. The collimator sight ensures that information about the sequence of launch operations is displayed on the display. A 20-kilogram missile in the TPK and a 20-kilogram stand (tripod) with equipment are carried by the commander and the gunner, respectively. In the traveling state, the MANPADS is transported on a light chassis to the deployment site in a combat position.

The propulsion system includes the starting (accelerator) and sustainer engines. Flight control is carried out by two pairs of movable canard-type rudders located in the front part of the hull. The high-explosive fragmentation warhead uses 1 kg of explosive and tungsten balls to increase the penetrating effect. The warhead is located next to contact and non-contact fuses to increase detonation.

An active laser type proximity fuse has an operating range of about 1 m when used against approaching and low-flying targets. He is more disruptive

protected compared to other types of non-contact explosions

agents that may trigger false alarms prematurely

ny goals.

The cooled passive IR seeker is produced using the technology used in the R-550 Magic-2 air-to-air missile, and has a multi-element sensor with digital processing of target radiation in two channels: 3-5 microns in infrared and ultraviolet ranges. This increases the sensitivity of the seeker (almost 3.5 times compared to the Magic-2 missile),

which makes it possible to destroy aircraft at ranges of up to 6000 meters and an altitude of 4500 m.

Helicopters are towed to an altitude of 4000 m and above. In both cases, the line of sight of the approaching target should lie within +38° from the seeker axis. The IR seeker is used to reduce target

visibility. The maneuverability of the missile in the final phase of flight increases, allowing it to hit targets maneuvering with overloads of up to 7-8g. During the battle, the crew commander, interacting with the fire control center, identifies the target and

prepares the complex's equipment. The shooter performs pre-launch

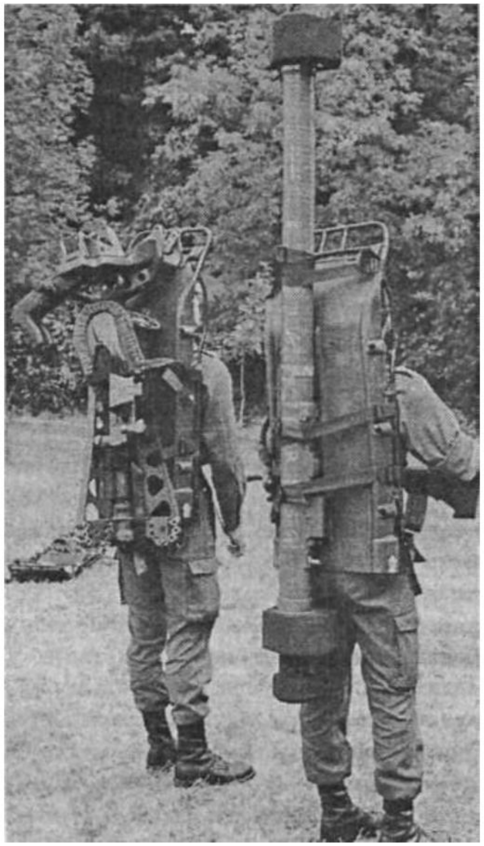
operation, locks onto the target for auto tracking and opens fire. The launcher seat for

the shooter is height adjustable. The launcher is horizontal along with a seat and two palm rests, which are equipped with a safety mechanism to avoid accidental discharge when working with the surveillance system. Removing the safety lock includes the battery, cooling system, rocket gyro and trigger mechanism.

The missile located in the TPK is connected to a power source, sighting equipment and a ground-based electronic unit. The latter determines the field of view and sensitivity of the seeker, using for this purpose the data received from it when reviewing the most important directions. Then the unit either automatically rejects the false target or confirms its truth by calculating information on the target for firing at it. The power supply powers the rocket before launch, as well as the working substance of the cooling system, necessary for cooling the seeker receivers. After switching on, the power supply operates for 45 s, then it must be replaced. About 60 seconds are required to bring the MANPADS into combat-ready condition. Target designation can be obtained from the crew commander, using radio information from an external radar unit or visual information obtained using binoculars.

There are two more options: using the information displayed on the azimuth display of the launcher (the display receives information from the fire control system), and independent use of the sight.

la shooter.



Carrying the complex by calculation

When a target appears in the designated azimuth direction, the shooter captures it using an optical system (3x magnification). Tracking data is displayed using a collimator system, which allows it to perform pre-launch operations: remove the general fuse and engage the seeker fuse. Starting up the power supply powers the cooling system and after 2 s the system is ready to track the target, the data is sent to the electronic unit. When the target is in the launch zone, the shooter presses the trigger. Starting motor

accelerates the rocket to 40 m/s. To protect the shooter from the blaster effect, the accelerator is turned off before the missile launches from the TEC.

At 15 m from the launcher, the accelerator separates and in 2.5 s the main engine accelerates the rocket to a maximum speed of M2.6 (850 m/s). The missile is aimed at the target using an aiming device; the optical sight allows

track the target with anticipation in azimuth and elevation. An optical IR sight (if any) is used when firing at night, the missile is aimed at the gas jet of the engine using the on-board IR (UV) seeker, and at the final stage of the flight the missile adapts its flight profile so as to cover the target.

The rocket fairing, which ensures the transmission of infrared radiation, is made in the shape of an octagonal pyramid. This reduces the drag of the rocket and increases the average

low speed of its flight.

The maximum flight time of the rocket is 12 s (including 2.5 s in the upper stage). After the shot, a new one is inserted instead of an empty TPK (time taken - 10-30 s). The reaction time of the complex in the absence of target designation (from the moment the target is detected until the missile is launched) is about 5 s. And if there is target designation, 3 s is enough, which allows you to carry out multiple attacks on targets using a disposable launcher. Modifications of the complex: • ALAMO (Affut Leger Anti-Aerien Mobile) on a lightweight chassis. The Mistral

MANPADS can be installed on a

light jeep-type chassis, FL-500 chassis, VLRA ASMAT 4x4 or Matra Poncin chassis;

• ALBI (Affut Leger Biminition) - twin installation. The ALBI system, based on the Mistral missile with two guides, is designed for use on a lightly armored tractor or wheeled chassis (such as a Panhard VBL or SMS VAB) to protect troops on the move or vital installations. The chassis can additionally be equipped with night vision systems and a “friend or foe” identification system; • ATLAS (Affut Terretre Leger AntiSaturation). Modernized

bathroom twin above ground system is designed for

stationary use or use on a chassis to protect vital facilities, as well as military units on the march. Consists of a portable launcher, controlled by one person, with two missiles ready for combat and a control system similar to that used on the ALBI system. When using the ATLAS system on the chassis, it is possible to quickly remove the MANPADS and deploy them on the ground.

SANTAL - chassis with a tower system. There are six combat-ready missiles. ATAM (Air-to-Air Mistral). For the Mistral air-to-air missiles, the ATAM system has been created, where there are up to 4 missiles (70 kg - two-stage), installed on external pylons, and an electronic unit located inside the helicopter. The French army bought them for their Gazelle-type helicopters, which use a helmet-mounted sight. The system was tested on the AN-64N Apache helicopter and is expected to be used on the French HAP/HAC-Tigre helicopter. The first 30 systems were supposed to be delivered to the French army back in 1992; the delivery program was accelerated due to the results of the war in Persia.

Sky Bay.

Спаренная пусковая установка ПЗРК «Мистраль»

- SADRAL - marine version. For the Navy, a one and a half ton all-weather six-shot (System Auto-defense Rapproche Anti-Aerien Leger) system is used for ships of all types. This modification was supplied to Finland and Qatar.

• Simbad Lightweight Twin-round Naval System. This is a naval version of the lightweight twin launcher, designed for small ships of all types, including support ships to provide anti-aircraft protection. The Simbad system can complement any type of 20 mm anti-aircraft guns and is planned for purchase by Cyprus, Norway and France (28 launchers in 1992). • Platoon Mistral Command Center (PMCE). RMSE was first shown in 1991 at the Paris Air Show, created for use with Mistral MANPADS or the ATLAS system to protect military units, mechanized units or vital installations. The system is based on existing equipment and includes: a surveillance and fire control radar with an Identification Friend or Foe (IFF) system, a combat control station for one or two operators, a terminal connected to each MANPADS or to the ATLAS system, information transmission unit (voice and data) to TDMA, control system, connected

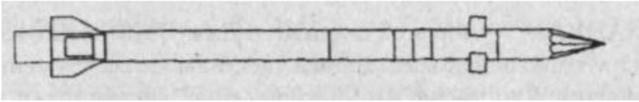
communication with a higher command post.

The entire system (with the exception of terminals) is located on a highly mobile air transportable chassis.

Mistral MANPADS are in service with Austria, Bel-gy, France, Finland, Italy, Norway, Spain.

In total, more than 10,000 missiles were produced, taking into account that serial production began in 1989.

In addition, a total of 78 Thomson-CSF Samanta detection systems (on a TRM-2000 or ASMAT VLRA chassis) were supplied for use in conjunction with the Mistral MANPADS.



TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:

maximum (depending on target type) 4.0—6.0 0.3 minimum

Damage height, km:

maximum 4.5

minimum 0.015

Length, m:

missiles 1.86

missiles in TPK 2.0

Missile diameter, m 0.09

Wingspan, m Weight, kg: 0.19

missiles

missiles 18.4

in TPK warhead 21.4

Warhead type 2.95

Maximum missile speed, fragmentation

M Engine type 2.6

solid fuel

with solid propellant accelerator Guidance

system IR (UV) passive homing Launcher portable, can be installed on a chassis

RBS-70

(ШВЕЦИЯ)

In the late 60s, the Swedish Air Defense Committee, when developing the country's air defense concept, came to the conclusion that the most optimal would be a combination of short-range air defense systems and SAAB JA-37 Viggen fighter-interceptors. The proposed version of the air defense system required financial costs and, moreover, assumed interference immunity when operating in conditions of strong enemy radio countermeasures. The committee also recommended replacing the brigade-level 20mm and Red Eye (Swedish designation Rb-69) anti-aircraft systems and the 40mm anti-aircraft and 57mm Bofors guns with newly created systems.

The contract for the development of a short-range air defense system called RBS-70 was concluded in 1969. It involved the creation of a missile located in the TPK, without a receiving device. It was believed that the target would be detected visually

alno. Later it turned out that the effectiveness of the complex will be significantly higher when using a detection radar and a "friend or foe" identification system. The first production samples of the RBS-70 missile, sights, friend-or-foe identification system, as well as detection radar were released in 1979. A version of the complex, operational in daylight conditions, was adopted by the Swedish army in 1977.

At the end of the 90s, the Swedish division was armed with an air defense company with the RBS-70 complex. The air defense company has three missile platoons, each of which has three RBS-70 fire systems and a radar platoon consisting of two SAAB-Scania Toure-40 4x4 all-terrain vehicles, on which a PS-70/S Basic Giraffe radar is mounted, as well as equipment

communication tour.

The creation of the RBS-70 complex was fully completed after the introduction of a wide viewing beam for the laser receiver installed on the rocket. This expanded the affected area by 30-40%, depending on the tactical situation. Anti-aircraft protection of the four Swedish mechanized brigades is provided by air defense companies, which are armed with

There are modernized versions of the complex on the Lvrbv 701 chassis.

In 1986, work began on updating and modernizing the RBS-70 complex. Their completion was planned for the end of 2000. Since 1984, a version of the complex called RBS-70M began to be created, with which it would be possible to conduct combat operations at night. As part of this option, a new thermal imager, surveillance and target tracking radar "Giraffe-75" was created .

It was developed for the air defense forces of the Norwegian army low-altitude anti-aircraft missile system, called tion of NALLADS, which is an RBS-70 air defense system equipped with an upgraded Giraffe radar. The Gi-raffe 50AT (All Terrain) radar, which has a specially designed digital data processor, was designated NO/MPY-1. The equipment is installed on a Bv 206 tracked chassis,

which also houses the power plant for

equipment power supplies, communications equipment, target tracking equipment. The radar operates in the G-band and has "friend or foe" identification equipment. The antenna rises to a height of 7 m on a manipulator with a retractable link.

The Giraffe 50AT radar provides automatic detection, tracking, identification and threat assessment of targets and can track up to 20 of them. Operator workstations are equipped with color displays. The radar can issue target data to 20 RBS-70 complexes via specially organized communication channels. Up to three NALLADS systems can be combined into a network structure to provide air defense for particularly important areas. Deliveries of the new system to air defense forces began in 1992.

Target detection and tracking radar Giraffe 50AT

Giraffe 50AT provides the following characteristics:
detection:

- range 70 km, altitude 7 km on target with ESR 10 m^2;
- range 50 km, altitude 5.2 km against a target with an EPR of 3 m^2;
- range 37.5 km, height 4 km on target with EPR 1 m^2;
- range 22.5 km, height 2.2 km on target with EPR 0.1 m^2.

In 1990, a new version of the complex began to be created - RBS-90, which is used both in stationary and in portable options.

The PvBS-70 missile has a solid-fuel rocket booster and a solid-fuel propulsion engine, and is housed in a transport and launch container. After the rocket launch, the container is not reused. The high-explosive fragmentation warhead contains 3,000 tungsten fragments with a diameter of approximately 3 mm. A non-contact fuse is used in the near zone to avoid premature operation when reflected from the ground, water, or snow. When firing at helicopters flying around the terrain, the proximity fuse can be turned off manually by the shooter using a switch located on the left side of the TPK. The penetrating effect of fragments allows the destruction of lightly armored vehicles. The missile contains a receiving device that allows the missile to be aimed at a target in the center of the laser beam using an on-board microcomputer that converts signals differences in guidance impulses.

The maximum height for hitting a target is 4 km, the minimum height is ground level. The upgraded Mk.I missile is essentially the same missile, but uses a laser guidance sensor pod that increases the field of view of the rear hemisphere from 40° to 57°. This significantly increases the affected area of the complex. The Mk.2 rocket differs significantly from the previous one in its electronic filling, but has the same overall dimensions and weight. The electronics were significantly miniaturized to increase the size of the propulsion engine and warhead. The new main engine made it possible to increase the speed of the rocket, as well as the flight range to 7 km versus 6 km when firing at low-speed targets and increase the maximum

new height from 3 to 4 km. As a result, at the far edge of the affected area, the missile has a slightly higher speed than its predecessors. The main firing unit consists of two main elements: a stand and a sighting device. Each of them is carried by one member of the crew, the third carries the rocket to the TPK. If necessary, identification means can be added, which are carried by another member of the calculation. In addition, he is also entrusted with a terminal for connecting to a Giraffe-type surveillance radar in order to obtain data ny about goals.

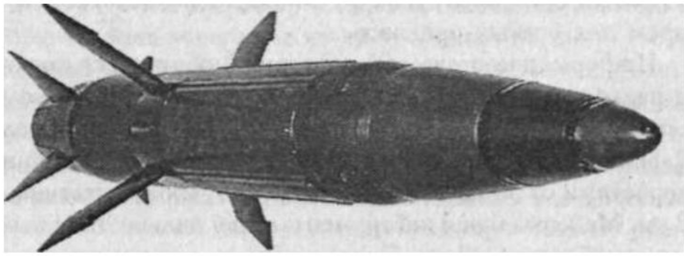
For combat work, the launcher is placed on the ground, its rough leveling is done by changing the length of one of the legs of the tripod. The operator's seat is unfastened from the central tube, then a gyro-stabilized sight, a power source, an identification system and a TPK with a missile are connected. A trained calculation performs all these actions in 30 seconds. When RBS-70 operates in the same network with the Giraffe 40 PS-70R radar (operating in the G-band), mutual orientations are carried out rization and topographical reference using a prismatic compass. An air defense company with radar support from the Giraffe 40 PG70R radar covers a 250 km area of terrain ^{2} taking into account mutual cover. The radar has a moving target selection system. To increase the detection range of low-altitude targets, the radar antenna is raised to a height of 12 m using a hydraulic mast. Three radar operators detect and track targets using a all-round indicator (PPI - Position Plan Indicator). The fourth person in the combat crew plots the situation on a map, which is used by the commander for combat orders.

Information about the distant air situation is sent via radio link to the surveillance radar from a higher command post. Maximum target detection range with an effective dispersion area of 3 m^2 and 0.1 m^2, flying at speeds from 30 to 1800 m/s is 28 and 12 km, respectively. The maximum instrumental target detection range is 40 km. The target's speed, course and direction are transmitted to fire systems (the maximum number of them

can reach 9) either via radio link or cable to the information receiver in the sequence determined by the radar commander. By using information from the detection radar, the firing unit can destroy a target on the far border of the affected area.

The information receiver computer (on the fire complex) processes the information received from the radar, calculates the coordinates of the target, displays the target on a small indicator and transmits an acoustic signal to the shooter's head phones, who turns his sight and trigger device in the direction where the maximum sound signal is heard. He rotates the starting device using two handles. The shooter searches and detects targets in this direction. When a target enters the affected area, the combat crew is notified about this using an information receiver, and the shooter

launches the rocket using the launch button, which he presses with the thumb of his left hand. The laser guidance system starts working, the launch engine starts, and the missile breaks the front wall of the TPK. To ensure the safety of the shooter, the starting mode of engine operation stops after the rocket has completely exited the TPK; the starting engine is reset a few meters after the rocket takes off, with 4 stabilizers located in the center and 4 tail cross-shaped rudders deployed. The main engine starts working, the guidance system receiver works out the direction



Anti-aircraft guided missile "Bofors" RBS 70 Mk.2

summer transmitted by a laser beam. The on-board computer generates rudder control signals depending on the signals received by the receiver. The maximum flight speed of the rocket is achieved at the moment the propulsion engine ends operation. Then it continues to fly with the engine turned off. To hit a target, the shooter must hold the target in the crosshairs of the gyro-stabilized sight using a joystick.

In the absence of information from the surveillance radar, a post is set up for early visual detection of the target. The shooter independently searches for the target. When a target is detected
and turning the system in the direction of the target, it launches the electrical equipment of the rocket (after 5 s) and carries out precise aiming using an optical sight. If you have
When the identification system is installed, the target is automatically identified. When receiving information about tracking your own aircraft, the launch is blocked and the light indication on the sight lights up. The shooter stops working and puts the switch on safety. For exactly-

For automatic target tracking, the shooter uses a 7x sight with a field of view angle of 9°. The range to the target is estimated using a scale grid. If the size of the target has become twice the central interval of the scale grid, then the target is outside the affected area. When

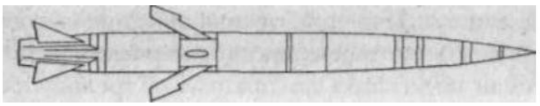
the target is in the affected area, the shooter launches the missile. The reloading time of the firing unit is 7 s. The empty TPK is discarded. The cover is removed from the TPK connector, it is attached to the stand, as a result, the TPK is electrically connected to the power source and the contacts of the combat signal transmission circuit from the signal source to the aiming device are closed.

The RBS-70 VLM complex is installed on any wheeled or tracked chassis. It is assumed that the firing unit located on the chassis is dismantled and used autonomously. It has one missile in combat readiness and 6-8 in reserve. The classic chassis for the RBS-70 is the British Land Rover all-terrain vehicle - 4x4.

RBS-70 is mounted on the M113A2 chassis. In such a complex tation it was supplied to the Pakistani army.

To ensure operation at night, the RBS-70 COND (Clip On Night Device) is equipped with a night sight, which at this time of day uses 23 sensitive elements, weighs 24 kg (including batteries and a refrigerant tank), operates in the infrared range from 8 up to 12 microns, equipped with a scanner for target detection. The latter allows you to detect airplanes at a distance of up to 10 km, helicopters - up to 6 km.

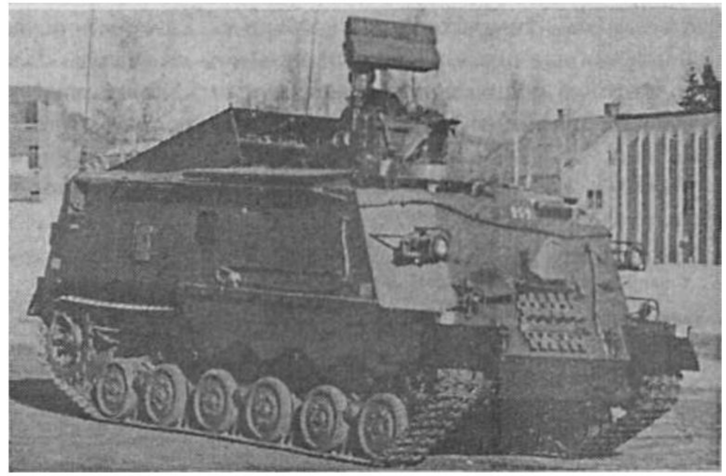
Delivered to the following countries: Australia - 60 complexes, Bahrain - 70, Venezuela, Indonesia, Iran, Ireland - 4, Mexico, Norway - PO, Pakistan, United Arab Emirates, Singapore, Thailand, Tunisia - 60, Sweden. In total, in 1998, about 1,000 MANPADS and 14,000 missiles were produced.



TACTICAL AND TECHNICAL CHARACTERISTICS OF THE MK.2 ROCKET

Damage range, km:	
maximum	7.0
minimum	0.2
Damage height, km:	
maximum	4.0
minimum	ground level
Length, m:	
missiles	1.31
missiles in TPK	1.74
Diameter, m:	
missiles	0.10
missiles in TPK	0.15
Wingspan, m Weight,	0.32
kg: missiles	
missiles	16.5
in TPK	26.5
Maximum missile speed, m/s Deployment	580
time, s Reaction time, s	30
Guidance system	6
	by laser beam

RBS-70 on Lvrbv chassis
(SWEDEN)



The RBS-70 short-range complex on the Lvrbv chassis is intended for air defense of armored and mechanized formations of the Swedish army.

This complex can be considered a successful example of extending the service life after modernizing the chassis of anti-aircraft artillery guns Ikv-102 and Ikv-103. The modernization was carried out after the successful testing of a prototype chassis in 1983. The first complexes were put into service in

1984. The modernization of the chassis was extensive and included the replacement of the engine and transmission. In addition, it was possible to make the combat crew's workplaces more secure and comfortable, and new means of communication and space surveillance appeared. The driver's seat of the chassis is located in the front of the hull

on the left side and is equipped with fixed periscopes for viewing the area from the front and sides. The commander's seat is located to the right of the driver, and he can use

use rotating periscopes.

The conduct of combat operations is in many ways similar when using using the RBS-70 portable air defense system.

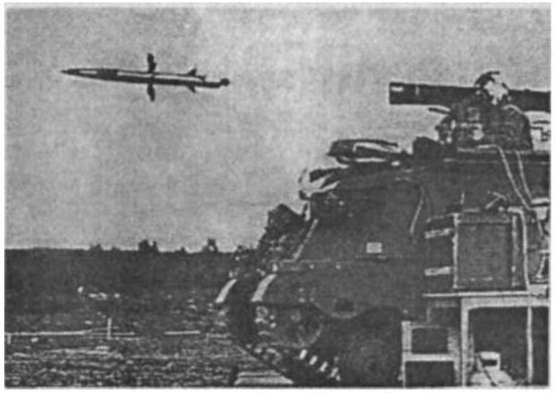
Launcher of the RBS-70 anti-aircraft missile system

is located inside the body and rises up when unfolded
standing on the ground during preparation for combat operations. The identification system is mounted on top of the missile container. Spare missiles are stored inside the housing,

located above the engine in a special feeding compartment
lenition, which raises them upward when reloading.

Crew - 4 people: commander, gunner, loader and driver.

Serial production has been completed. It is in service with the Swedish army.



TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:

maximum (depending on target type) 6.0—7.0 0.2 minimum Damage height, km:

maximum 4.0

minimum Missile ground level 1.32

length, m Missile 0.10

diameter, m Wingspan, m 0.32

Weight, kg: missile

warhead, kg

16.5 (Mk.2 missile)

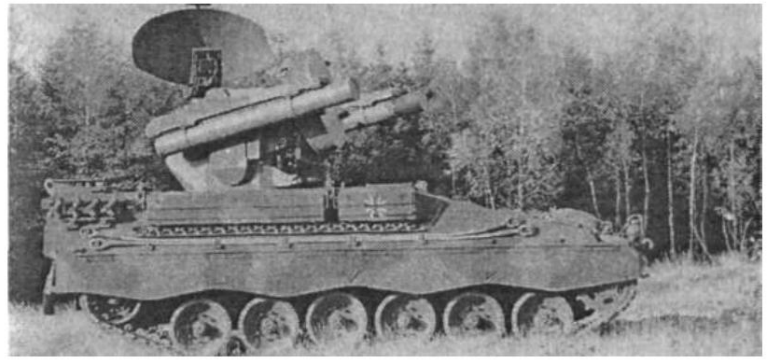
2.95

Maximum rocket speed, M Warhead type about 2

high-explosive fragmentation
with contact and non-contact
laser fuses solid propellant with a
engine's type solid propellant accelerator
along a laser beam
Guidance system

SELF- PROPELLED ANTI- *AIR MISSILE SYSTEMS*

"Roland 1", "Roland 2", "Roland 3" (GERMANY, FRANCE)



In 1964, the French company Aerospatiale and the German Messerchmitt-Bolkow-Blohm (MVB) began joint work to create an air defense system designed to destroy targets at low altitudes. Later the complex received the name “Roland”. The French company Aero-spatiale became the lead contractor for the all-weather version of the complex, the Roland 1 version, and MVV (the current name of the company is DASA) began developing the all-weather version of the complex, Roland 2. Now a joint company, and this is Euromissile (Eurorocket), offers on the market missiles of this system and the currently produced version of the complex - “Roland 3”.

The first tests of the Roland complexes for the German armed forces took place in 1978; they were used to replace 40-mm anti-aircraft guns of the L/70 type from Bofors. In 1981, the German armed forces officially received 140 Roland air defense systems. The first combat crews were trained at the air defense school located in Rendsburg in 1980. In 1981, the 100th air defense regiment of the German army began rearmament, then in 1982 the 200th regiment rearmed and in July 1983 - 300th Regiment Each regiment had one control battery, three

fire batteries (each with 12 fire units) and one support battery. In the German army, the Roland complex is located on the Marder 1 chassis, manufactured by Thyssen Henshel. In December 1983, the Roland 3 complex (stationary version) was chosen to protect NATO air bases (USA and Germany) located in Germany. A total of 95 firing units were installed, of which 27 covered 3 American air bases, 60 covered 12 German airfields, and the remaining 8 firing units were used for training. All 95 complexes were served by German combat crews. 20 Roland complexes were intended to protect three German naval aviation airfields.

DELIVERY OF THE ROLAND COMPLEX BY RANGE OF THE ARMED FORCES

Type of forces	1986	1987	1988	1989	1990
US Air Force			16		
German Air Force	3	8 2	14	3	16
German Navy	-	-	6	33 8	6

Subsequently, the complex was installed on an all-terrain vehicle (8x8 wheel arrangement) from MAN, which had a number of advantages, for example, a new three-seater cabin. In February 1988, AEG supplied the German Air Force with the first fire control system - a command post. A total of 21 sets were supplied.

SAM "Roland 3"

Two-coordinate RAS with linearly frequency modulated The signal can distinguish an airplane from a helicopter, as well as detect anti-radiation missiles (ARM) and hovering helicopters. The maximum elevation angle when viewing space is 60° from the lowest altitudes to a height of 6 km. Detection range range

target with an effective reflective surface of 1 m^2 ranges from 46 to 60 km.

The antenna is mounted on a mast that is hydraulically raised to a height of 12 m. The entire antenna system is deployed and put into combat readiness in 15 minutes.

Two workstations are deployed in the operator section of the station. national version of the complex, one for analyzing the air situation, the second for operational control. The other two sections are the electronic complex and the systems complex.

protection with cooled transmitter, air conditioning.

The command post (FGR) detects targets (this allows the Roland complex not to turn on its own surveillance radar, thereby increasing its survivability), processes information on the target and displays it on the air situation indicator with an indication of the type of threat. The commander of the command post selects one of his weapons. The command post can accommodate up to 40 missile and anti-aircraft systems. An extensive radio network and cable communication lines make it possible to transmit all information on a target (target designation) to the selected weapon system so that the target is timely detected and captured for tracking. Target designation and exchange of information with the selected fire system are transmitted via radio or wired communication lines. SEL SEM 80, SEM 90 radios or field telephones are used to transmit voice information. The data exchange cycle is two

seconds.

For the joint combat use of the Roland and Gepard complexes, the German armed forces use a command post of the HflaAFuSys type. It consists of a PAC on an armored Marder 1 ICV chassis with a hydraulic tower (folds in half). A rotating RAS antenna is placed on top, allowing three times the line-of-sight range. The crew of this command post consists of

four people. Equipment - indicator and electronic equipment MPDR 3002-S 2D E-band radar, friend-or-foe interrogator type DII 211 (formerly MSR400/9), two workers

operator positions, a computer system for analyzing the air situation, a communication system, power supply, cooling systems and hydraulic equipment. It has its own navigation system for accurate topographical reference.

Testing of the standard radar on the TUR chassis was completed at the end of 1988, and they began on the first prototype at the end of 1981.

DELIVERY OF THE ROLAND COMPLEX

Modernization of "Roland 1" missile firing unit mod. 1B	country mod.1A France	Germany	"Roland 2" rocket firing unit	
France				
Germany	34	1244		
mod. 2	-	-	39	790
France				
Germany	46	1440		
mod.3	-	-	50	1684
France				
Germany	-	680	36	1010
mod. 4	-		51	6520
France				
Germany	-	-	40	2045
mod.5	-		-	-
France				
Germany	-		20	836
3770 Note.	-		-	-
In				
addition to	-		-	-
	-	-	115	

the 3,770 missiles of the Roland 2 mod.5 complex, Germany has about 1,030 Ro.land 3 missiles in service with the Air Force. Currently, the Roland 2 complex is capable of destroying targets flying at speeds up to Ml.2 at altitudes from 10 m to *5.5* km and at ranges from 500 m to 6.3 km. The complex has optical and radar combat modes. In the process of combat work, it is possible to quickly

Swarm mode switching.

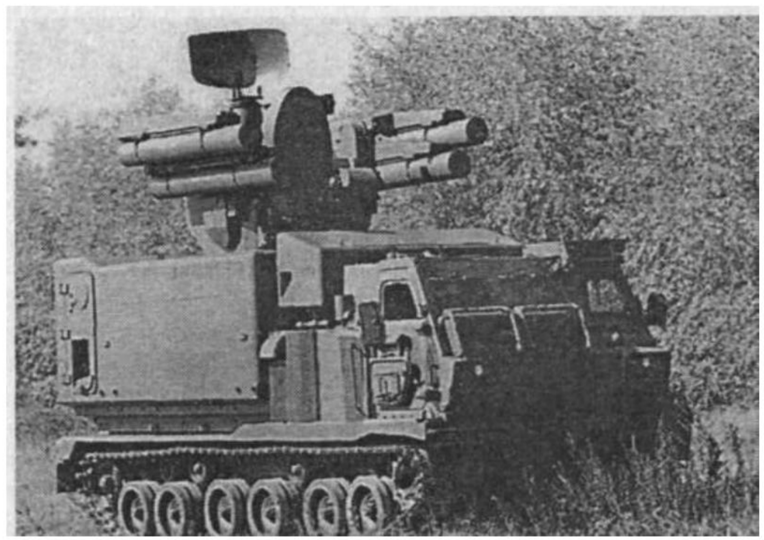
In both modes, initial target detection occurs using pulse Doppler surveillance radar

type Siemens MPDR 16 D-band, rotating at a speed of 60 rpm and automatically detecting targets.

The radar also has the ability to detect hovering helicopters. When a target is detected, it is identified using the Siemens MSR-40015 interrogator (on a German chassis) or the LMT NRAI-6A type (French chassis), and then it is captured for tracking or tracking radar (radar mode), or with the help of an operator using an optical system (optical mode). In optical mode, the missile is aimed along the operator's aiming line as follows. The sight measures the angular velocity of the target, the IR rangefinder determines the deviation of the missile relative to the guidance line. Using this data, the computer calculates the required guidance commands, which are transmitted to the missile

via radio link. The signals are received by the rocket, and its rudders are deflected accordingly. The tracking radar is mounted on the front side

chassis, this is a two-channel monopulse Doppler stan-



The Roland-3 complex based on the American M548 tracked transporter

tion type Thomson-CSF Domino 30. One channel tracks the target, and the second captures the microwave source (transmitter) on the rocket for tracking.

After launch, the IR rangefinder located on the radar antenna tracking, is used to capture a missile at ranges of 500-700 m, since the narrow beam of the tracking radar is only formed at these ranges. The second tracking channel is designed to guide the missile by transmitting commands to its board. Information about the missile's deviation from the line of sight (antenna-target) is converted by the computer into commands to deflect the missile's rudders in the same way as when working in optical mode.

As mentioned above, it is possible to switch from optical guidance mode to radar and vice versa. IN
In these situations, the target must be accompanied by fire units. This significantly increases the noise immunity of the Roland complex.

The two-stage solid-fuel rocket has a dead weight of 66.5 kg, of which the warhead is 6.5 kg, including 3.3 kg
explosive substance that detonates on contact or
proximity fuses. Maximum damaging radiation

Пуск ракеты комплексом «Roland 3»

The flight distance of 65 fragments is about 6 m plus the impact of the blast wave. The missile has a cruising speed of M1.6, length is 2.4 m, wingspan is 0.5 m, its diameter is 0.16 m. The missile is located in a container (TPK), which is used for its launch. The weight of the equipped TPK is 85 kg, length is 2.6 m, diameter is 0.27 m. The duration of operation of a solid rocket accelerator of

the SNPE Roubaix type with a thrust of 1600 kg is 1.7 s, it accelerates the rocket to a speed of 500 m/s. The SNPE Lampyre type rocket engine has an operating duration of 13.2 s, is located in front

of the accelerator, and turns on 0.3 s after the accelerator is fired. The maximum speed of the rocket is achieved when the engine stops running. The minimum flight time required to launch the rocket onto the trajectory is 2.2 s. The maximum flight time is 13-15 s. Two missiles are constantly ready for launch, and the remaining 8 missiles are located in revolver-type stores (each with 4 missiles). The upgraded missile of the Roland 3 complex has an increased flight

speed (570 m/s compared to 500 m/s) and destruction range (8 km instead of 6.3 km). It was put into service in 1989 and, while maintaining the same

dimensions of the missile, has a warhead weighing 9.2 kg, which contains 5 kg of explosive and 84 fragments to increase the destructive effect.

The improved contact fuse is connected to a new fragmentation warhead, which has a maximum fragmentation speed of 5000 m/s (increased by 2.5 times compared to the Roland 2 rocket). This increases the damaging radius of the fragments. The maximum flight time is approximately 16 s, the weight of the rocket is 75 kg, and in the container it weighs 95 kg. The operating time of the new rocket accelerator determines the

minimum effective destruction range (500 m), but at the same time the maximum height of targets hit has been increased by 500 m, and is 6 km. The target overload value has also increased (up to 9g), at which the missile will destroy it at the far edge of the affected area.

The preparation time for launching the first missile is six seconds; for launching the second, depending on the type of target, it takes from two to six seconds. Recharge time -
The release time of a rocket from a revolver magazine is six seconds. New missile ammunition can be charged within 2-5 minutes.

If it is necessary to cover air bases or other important facilities, eight Roland complexes can be combined into a single air defense system, as is done in Germany. Up to 6 Roland complexes can interact with each other, forming a mutual cover network. Anti-aircraft weapons and portable air defense systems can receive information about all targets detected and tracked by the complex

Roland.

In 1988, the French and German ministries of defense adopted a program to modernize Roland air defense systems in order to extend their operation until 2010.

It is planned to replace the existing optical sight with an optoelectronic integrated sight GLAIVE, which provides the third mode (IR) of the complex's operation for firing at a target, as well as simplifying the human-machine interface by using microprocessors located in the cockpit and computer equipment known as cipher BKS system. In 1992, Euromissile created a prototype air defense system, the Roland M3S, which was intended for export.

It was offered to Thailand and Turkey to create an air defense system

at low altitudes.

The Roland M3S complex has a Dassault Electronique Rodeo 4 (or Thomson-CSF) radar and can be operated by one person, although two people are required for prolonged combat operations.

The operator can select any detection mode, for example, radar, TV or optical. The standard armament of the Roland M3S complex consists of four Roland missiles, combat-ready and located on the launcher. Other types of rockets are also used, such as two Matra rockets. Four Stinger MANPADS missiles or new VT-1 missiles of the Crotal complex can also be mounted.

The Roland complex was available in the US Army National Guard, but was withdrawn from combat service in September 1988. The Roland

complex is in service with a number of countries. Brazil received 4 Roland 2 Marder complexes from Germany along with 50 missiles. In 1984, the Spanish Ministry of Defense chose the Roland complex to equip its mobile low-altitude air defense batteries, a contract was signed

path on data integration and co-production
new weapon system (9 all-weather complexes and 9 all-weather systems on the AMX-30 MVT chassis with 414 missiles).

Argentina used a stationary version of the Roland complex in the Falklands War of 1982 to protect the city of Port Stanley from airstrikes by British naval aviation. Between 8 and 10 missiles were fired and one Sea Harrier and two 454 kg bombs were shot down. During the landing of British troops, the complex was captured intact.

Iraq also used its Roland systems in the war against Iran.

NUMBER OF ROLAND COMPLEXES IN VARIOUS COUNTRIES OF THE WORLD

Country	Quantity	Type of armed forces	Note 4 Stationary version 4
Argentina		Army	
Brazil		Army	"Roland 2", chassis "Marder 1"
France	181	Army	"Roland 2", chassis AMX-30
Germany	20	Navy	Roland 2, 8x8 chassis
	144	Army	"Roland 2", chassis "Marder 1"
	68	Air Force	"Roland 2", chassis 8x8
Iraq	13*	Army	"Roland 2", chassis AMX-30
	100*	Army/Air Force stationary version Army	
Nigeria	16		"Roland 2", chassis AMX-30
Qatar	3+6	Army	3 "Roland 2", AMX-30 chassis and 6 "Roland 2" on MAN chassis (8x8) AMX-30
Spain USA	18 27	Army Air Force	chassis "Roland 2", 8x8 chassis, German combat crews
Venezuela	6	Army	"Roland 2", stationary version The number

* of complexes could decrease due to combat actions by Iraq.

In November 1986, the Qatari army placed an order for three batteries of three complexes each. One battery used an AMX-30 type chassis, and the other two used a stationary type. The delivery and training of combat crews was completed in 1989.

At the beginning of 1991, the Roland complex (on chassis and stationary)

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Narny) was used by Iraq in the 1991 war against coalition forces (Operation Desert Storm). It is believed that the Roland complexes shot down two Tornado aircraft.

TACTICAL AND TECHNICAL CHARACTERISTICS OF MISSILES

	"Roland 2"	"Roland 3"
Maximum damage range, km	6.3	8.0
Height of damage, km:		
maximum	5.5	6.0
minimum	0.01	0.01
Length, m	2.4	2.4
Diameter, m	0.16	0.16
Wingspan, m	0.5	0.5
Weight, kg	66.5	75.0
Warhead mass, kg	6.5	9.5
Warhead type	high-explosive fragmentation with contact and proximity fuses	
Missile guidance method	command guidance	
Maximum speed, m/s	500	570
Loading time (from magazines), s	6	6

TACTICAL AND TECHNICAL CHARACTERISTICS OF MARDER 1 TYPE CHASSIS

Crew, people
Combat weight,
kg Ground pressure, kg/cm2
Chassis length, m
Chassis width, m
Height (with antenna folded), m Ground clearance,
m Maximum highway speed, km/h Fuel capacity,
l Maximum driving
range, km Height of obstacles to be overcome,
m Gradient, deg. Power supply, Armament

3 32
500
0.93

6.915 3.24 2.92 0.44 70 652 520 1.5 60 24 twin
Roland launcher with two missiles, 7.62 mm machine gun

LFK-LLADS

(GERMANY)

The LFK-LLADS (Low-Level Air Defense System) complex is designed for air defense of important ground targets, as well as for air defense of units on the march.

When creating the complex, the goal was to obtain a good ratio of cost and efficiency indicators and to occupy a niche between portable air defense systems and complex medium-range air defense systems (towed and self-propelled). The LFK-LLADS complex is equipped with equipment that

allows you to automate the stages of combat work, conduct combat operations day and night in all weather conditions and detect and fire at several targets simultaneously.

exactly.

Greater maneuverability is given by the possibility of air transportation of the LFK-LLADS complex. The CH-53G helicopter

two complexes are loaded, three into the C-130 transport aircraft, and four into the C-160 transport aircraft.

The first tests of a prototype of the complex with a GPS satellite topographical system and a thermal imager were carried out in 1993, and the complex participated in live-fire tests. In 1994, the prototype was modernized

to

reception of target designation received via radio communication from aircraft

of a new command post and tested. It is known that in 1996 the complex took part in tests conducted in low temperature conditions.

The platform with the complex equipment, stabilized in azimuth and elevation, is mounted on a Merce-des-Benz GD 250 chassis (4x4 wheel arrangement) with increased cross-country ability or on all-terrain vehicles such as Peugeot P4 or Land Rover. Various equipment is installed on the stabilized platform, including either an infrared (FLIR) system designed to detect and track a target (at night or in poor visibility conditions) or a LLLTV (Low-Light Level TV) television system), operating in conditions of poor visibility and to a limited extent at night, as well as a laser rangefinder, necessary for accurately determining the range to the target, mounted next to any of the above detection systems.

The shooter can conduct live fire using the control panel while in the cockpit, or at a distance from the chassis at a distance of up to 50 m.

Two ATAS (Air-to-Air Stinger) launchers weighing 43.6 kg each are mounted on each side of the chassis. Thus, the total number of combat-ready Stinger missiles is 4. An individual launch container is placed on the launcher, taking into account the integration of electronic and mechanical equipment, as well as the cooling system. At the request of a specific customer, any type of Stinger missile can be used.

The firing sector of the LFK-LLADS complex is 360° in azimuth and from -10° to +70° in elevation. There is an ammunition supply of 4 Stinger missiles carried inside the chassis. The chassis of the complex is equipped with communication equipment and an antenna, allowing

Now to receive information from a higher command post. There is a GPS (Global Positioning System) satellite system to provide accurate topographical location.

It is possible to use the standard ATAS Stinger launch module in conjunction with a 40 mm anti-aircraft gun Bofors L/70.

TACTICAL AND TECHNICAL CHARACTERISTICS OF THE LAUNCH PLATFORM PLACED ON THE MERCEDES-BENZ GD 250 CHASSIS

Dimensions, m:	
length	4.65
width	2.01
height	2.65
Weight,	2850
kg Number of combat-ready missiles,	4 or 8 70
pcs. Azimuth rotation speed, degrees/s	
Accelerated azimuth rotation speed , degrees/s	130
Ascent speed by elevation angle, deg/s	70
Accelerated ascent speed by elevation angle, deg/s	110
Reaction time, s	less than 5
Reloading time (for a crew of two people - four missiles), min IR system:	less than 2
wavelength, µm field	8—12
of view	Zx4 and 9x12o

TACTICAL AND TECHNICAL CHARACTERISTICS OF THE STINGER MISSILE (FIM-92C)

Length, m	1.52
Damage range, km:	
maximum	more than
minimum	4.5 0.2
Damage height, km:	
maximum	3.8
minimum	ground level 2.2
Maximum speed, M Length, m Diameter,	1.52
m Wingspan,	0.07
m Weight, kg:	0.09
missile	10.1
warhead Warhead	3.0
type Guidance system	high-explosive fragmentation
Engine	passive IR (UV) seeker solid fuel

ASRAD

(GERMANY)

Self-propelled anti-aircraft missile system ASRAD (Atlas Short-Range Air Defense) developed by the German company Atlas Electronik and is designed to cover ground forces facilities and units from air strikes on small and extremely low altitudes.

It consists of launchers located on a combat vehicle with four combat-ready anti-aircraft guns. new guided missiles in transport and launch containers, an optical-electronic device for tracking targets and missiles, a laser range finder and control equipment. Additional missile ammunition for manual reloading can be located in the combat vehicle. The air defense system has a modular design and can be installed on various armored vehicles and all-wheel drive vehicles. The complex uses missiles with passive infrared seekers "Stinger" (Basic, Post and RMP), "Starstreak", "Igla-1", "Mistral" and PvBS-70, RBS-90 with a laser guidance system. The combat crew fires at the target while in the vehicle's cabin, or from a nearby shelter, using a remote control device. To increase the effectiveness of the air defense system, it can receive information from the warning network from various detection radars, as well as

work together with other air defense systems. One radar can provide radar information to up to eight ASRAD air defense systems. Depending on customer requirements, the complex is supplied as a complete set or in parts. It is air transportable and can be delivered to the combat area by CH-53 helicopters. The ASRAD air defense system consists of the following main elements: • a platform rotating in angle and azimuth, on which launchers with missiles and missile control systems, detection equipment in IR and television range;

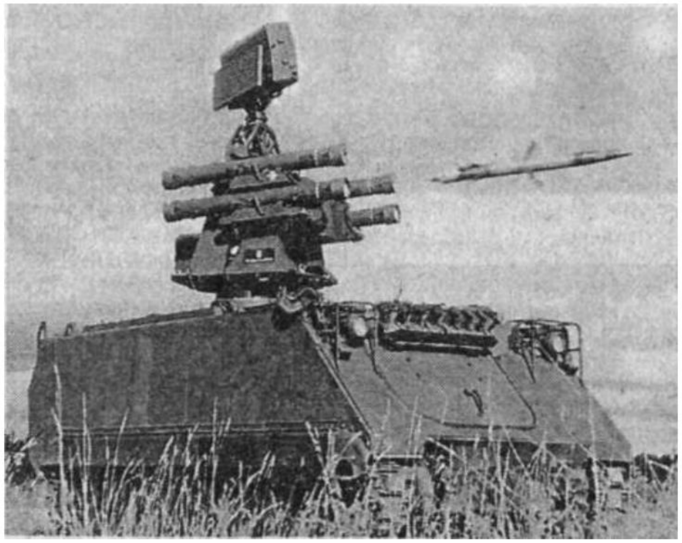
• control systems for platform rotation by angular coordinates; • control and display unit, which can be removed carried for remote control at a distance of up to 100 m from the launcher. A standard configuration air defense system can receive target designation from a platoon command post equipped with a detection radar that has built-in “friend or foe” target identification equipment and (or) an ADAD optoelectronic detection unit.

Detection radar

The air defense system can be equipped with its own search radar and (or) external target designation means. The operator can always monitor the air situation using his own detection means, which are a television camera and an infrared detector (thermal imager). To measure the range to the target necessary to calculate the missile launch range, the system is equipped with a laser rangefinder.

When receiving target designation from an external three-coordinate radar, the platform turns towards the target by angle and azimuth, and a target mark appears on the operator’s indicator. After this, the operator presses the automatic tracking button, and further tracking the target is carried out automatically, while the target is visible on the indicator as a triangle.

If target designation data comes from a two-coordinate detection locator, then the operator performs an additional search by elevation until a mark appears on the indicator. After this, the target is also taken on automatic tracking and data begins to be generated,



ASRAD-R complex with RBS-70 missiles on the M113ARS chassis

necessary for launching a rocket. In the absence of sources of external target designation, the operator can search for targets using his own detection means. The boundaries of the affected area are displayed on the operator's monitor. The same monitor displays information that the missile's homing head has captured the target. When the missile's seeker locks on a target, a sound signal is also issued. The complex is equipped with an automatic north orientation system, a GPS location system and radio communications.

Bofors, together with Atlas, have developed a version of the ASRAD-R complex, which uses RBS-70 Mk.l and Mk.2 missiles, and is also equipped with a three-dimensional detection radar manufactured by Ericsson Microwave Systems-HARD 3D. The complex can be placed on the Austrian Steyr-Daimler-Puch Pandur chassis (6x6 wheel arrangement) or on the M113ARS tracked chassis.

TACTICAL AND TECHNICAL CHARACTERISTICS

System weight, kg	about 320
Platform rotation angle, degrees: in	
azimuth by	360
angle	from - 10 to +70
Rotation angle of detection sensors relative to the platform, degrees: ±15 in azimuth	
Platform	from +4 to - 16 in angle
IR range rotation speed, degrees/s 56 Types of detection systems 8-12 microns, television camera, laser range finder constant voltage 18-32 V from the chassis on-board network	
Nutrition	
Dimensions of the affected area	determined by missile type
Types of missiles used	"Stinger", "Starburst", "Igla-1", "Mistral", RBS-70, RBS-90

ADAMS
(ISRAEL)

The complex is designed to protect troops and important facilities. com from air attack by manned and unmanned aircraft.

The ADAMS (Air Defense Advanced Mobile System) complex with a vertical missile launch can be placed on various types of chassis: LAV-25, M2 Bradley or MAN (8x8 wheel arrangement). Launchers can also be installed on the ground and have 8, 12, 16 or more combat-ready missiles.

The missiles are placed in transport and launch containers. Vertical each of which occupies an area of 0.1 m^2 the launch of missiles allows for its declination in a circular manner - 360° - thereby eliminating the need to spend time turning the launcher in the direction of the target.

The pulse-Doppler surveillance radar provides the complex with the necessary information for launching and guiding missiles to the target. The surveillance radar can track up to 20 targets with a speed range from M0.3 to MZ. There is a system of state target identification.

The missile guidance radar can search, support

driving targets and pointing missiles at them, although it is optimized for the latter two functions. The radar can operate in I/J and K-band wavelengths, providing target guidance for Barak-type missiles.

In difficult air conditions, in the presence of large electronic interference density can be used optical missile guidance system, although one temporary use of a radar guidance channel for missiles at one target and an optical guidance channel for another. The Barak missile is stored in a transport and launch container measuring 30x35x250 cm, with folded rudders and wings. A key characteristic of the Barak rocket is that 0.6 seconds after launch it can have an inclination angle to the horizon from -25° to +85°. This is achieved using a special design of a rocket engine with variable thrust vectoring. To achieve maximum

To determine the speed of the rocket, a rocket accelerator is used at the launch phase of the flight; after its operation is completed, an aerodynamic flight is carried out using rudders for maneuvering. During the final phase of the flight, when approaching the target, the rocket engine is switched on to achieve high maneuverability.

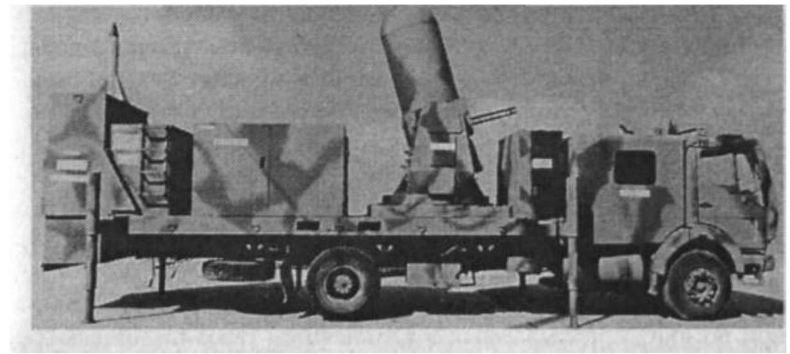
It was reported that the first combat missile launches took place in 1987 using Tow anti-tank missiles as targets.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum	12.0
minimum	0.5
Damage height, km:	
maximum	10.0
minimum	0.03
Rocket length, m	2.17
Rocket diameter, m	0.17
Wingspan, m Weight, kg:	0.68
rockets	88.0
warhead, kg	22.0
Maximum rocket speed, M over 2.0 Warhead type fragmentation with contact and laser proximity fuses	

HVSD/ADAMS

(USA/ISRAEL)



Anti-aircraft missile and gun system HVSD/ADAMS (High-Value Site Defense/Air Defense Advanced Mobile System) is designed to protect troops and important facilities from attack. airborne operations of manned and unmanned aircraft (including anti-radar missiles and guided bombs).

The air defense missile system is a further development of the ADAMS air defense system; it includes the Phalanx Mk.15 short-range naval anti-aircraft artillery system, which is in service with almost all warships of the US Navy and Israel, as well as a six-barreled automatic 20-mm gun.

The new complex instead of two target detection radars and missile guidance, the modernized multi-functional radar station "Phalanx" is used. All elements of the complex are placed on the chassis of a 10-ton Mercedes-Benz all-terrain vehicle (8x8 wheel arrangement). The M61A1 Vulcan anti-aircraft gun is equipped in a rotating turret, on which a radar is installed on top, and guidance and ammunition supply mechanisms are installed below. The ammunition includes standard Mk.49 rounds with armor-piercing sub-caliber projectiles (the tip is made of depleted uranium), ensuring effective destruction of both air and ground lightly armored targets.

The ADAMS complex uses a shipborne single-stage

a large anti-aircraft guided missile "Barak-1" from the "Rafa-el" company, made according to a normal aerodynamic design. Targeting is carried out using the radar beam using the three-point method. The missile defense system is equipped with a powerful high-explosive fragmentation warhead (its mass is 25% of the total mass of the missile) with tungsten destructive elements, the detonation of which is carried out by two fuses: contact and laser (remote, noise-proof). The latter simultaneously performs the function of a rangefinder and, 3 m from the target, reliably operates in the presence of interference caused by false reflections of signals from the earth's surface.

After a vertical launch and after 0.6 seconds of flight, the missile, in accordance with the program embedded in its on-board computer, with the help of subsequently reset gas-dynamic rudders, turns towards the target within 360° in azimuth and from -25° to +85° in angle places. To ensure the safe exit of the missile defense system from the TPK, where it is located with folded stabilizer consoles and rudders, and to reduce the impact of the gas jet on other elements of the air defense system, as well as to accelerate the missile to cruising speed, an engine with three modes is used (starting, accelerating and sustaining). Change in thrust in the corresponding sections of the trajectory

is achieved by charging solid fuel with a special profile with reduced smoke generation.

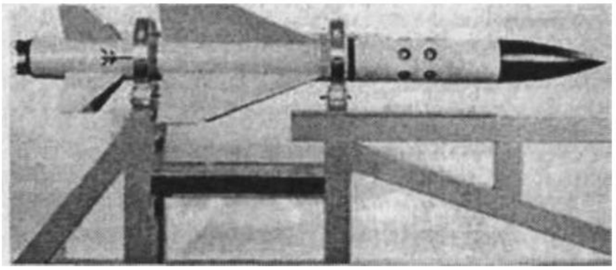
The missile defense system is placed in a sealed transport and launch container of a rectangular shape (245x25x30 cm) and is a product of guaranteed reliability. The vertical launch installation, including 12 TPK with missiles, has a mass of 2 tons and occupies a small area (about 1.3 m^2).

The modernized multifunctional pulse-Doppler radar "Phalanx" is located under a radio-transparent radome and has two antennas: target detection and weapon guidance (missiles or guns). In the automatic (main) mode of combat use of the complex, it detects and identifies air targets using the method of all-round visibility in motion. The fire control system, using a new high-speed computer, selects the most dangerous of them and issues target designation (firing sector) to the guidance antenna or (in conditions of complex interference)

situation) to an optical-electronic module with television and infrared tracking systems. After capturing a target for tracking, a weapon is selected to destroy it (missile defense or cannon). When a target enters the launch zone or effective firing of an artillery installation, a rocket is automatically launched or cannon fire opens. After establishing the fact of hitting the target by a sharp change in the parameters of its movement or exit from the launch zone, firing stops, and the radar again switches to the all-round viewing mode of the airspace.

Integration of gun and missile weapon systems into a single complex made it possible, according to Western experts, to create a highly effective anti-aircraft missile and gun system with a two-echelon destruction zone. In the first (main) echelon (at ranges of 2-12 km), targets are destroyed by the Barak-1 missile defense system, and in the second (0.5-2 km) - by artillery fire. The HVSD/ADAMS complex can be airlifted by C-130 transport aircraft. IN

Currently, the desire to purchase such complexes is expressed la Chile, whose Navy already has Barak ship-based air defense systems. In addition, in order to gain a foothold in the Middle East, In the new arms market, the Israelis offered an option to improve improving the tactical and technical characteristics of the Soviet-made ZSU-23-4 “Shilka” anti-aircraft artillery installations in service with a number of countries in this region and the “Osa” self-propelled air defense system (according to NATO classification - SA-8) by equipping them with the “Barak-8” missile defense system. 1".



SAM complex ADAMS

TACTICAL AND TECHNICAL CHARACTERISTICS

Firing range, km:	
maximum	12
minimum	0.5
Target engagement altitude, km'.	
maximum	10
minimum	0.03
Reaction time, s	6
Transfer time from traveling to combat position, min	5-10

ROCKET

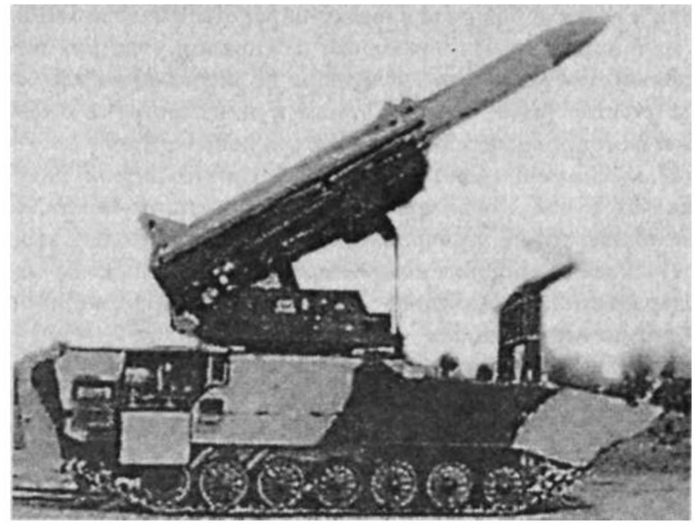
Launch weight, kg:	
missile	88
warhead	22
Length, m	2.17
Body diameter, m	0.17
Wingspan, m	0.68
Maximum flight speed, m/s	700

GUN

Caliber, mm 20
Effective range of
destruction of air targets, km:
maximum
minimum 2
Rate of fire, rds/min Magazine 0.5
reloading time, min Initial projectile speed,
m/s Projectile dispersion, m/rad Firing 4500
angles, degrees: in the vertical 6 1100 1.4
plane in the horizontal
plane Maximum pointing from -25 to +80
speed, degrees/s: in the vertical 335
plane in the horizontal plane plane
90
110

"Akash"

(INDIA)



The Akash mobile medium-range air defense system began to be created in India on the initiative of the DRDO (Department of Defense Research and Development Organization) as an integral part of the program to create modern missile weapons, started in India in 1983.

Military testing of the first prototype began in 1990, and the entire range of tests was completed in April 1995. Serial production was planned to begin in 1997. The firing battery includes three launchers and a towed chassis, which houses a missile guidance radar . The battalion includes a mobile command post (MCP - Mobile Command Post), which is capable of carrying out combat work, consisting of up to 4 fire batteries.

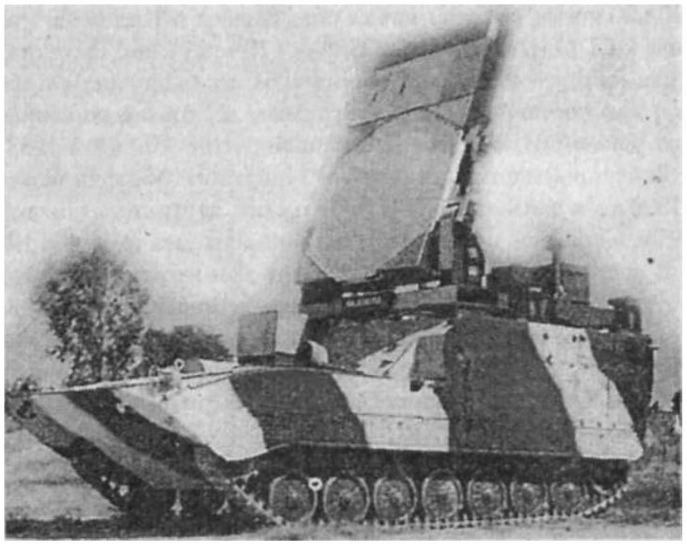
The missile of the Akash complex has a length of 6.5 m, weight - 660 kg and is in many ways similar to the anti-aircraft missile of the Russian SA-6 complex. The rocket uses a solid fuel accelerator, accelerating it to a speed of Ml.5, after which it is launched

The main rocket engine is installed, allowing it to reach a speed of M3.5. The rocket can withstand overloads of up to 20g. The maximum range of destruction of an air target is 27 km. The missile guidance system is of a combined nature. During the initial and main phases of the flight

command guidance is used via radio link at the final section (3-4 s before approaching the meeting point with the target)
The semi-active homing head is turned on.

The maximum height of the destroyed target is 15 km. The rocket's flight is controlled using rudders driven by a pneumatic drive. The launcher of the Akash complex was created based on the modernization of the Russian BMP-2 chassis, produced in India under license.

Three missiles are placed on a rotating launcher, which is mounted at the rear of the chassis. The equipment of a multifunctional radar with a phased array antenna (PAR) is also mounted on a similar modernized chassis. During transportation, the phased array antenna sheet is folded. The radar equipment includes a digital



Multifunctional radar

new processing of radar information, where coherent processing of the reflected signal is used using the fast Fourier transform. In addition, the radar provides instant tuning of the frequency of the emitted

signal.

The phased antenna consists of 4000 elementary C-band radiators, 1000 elementary X-band radiators. The antenna of the state identification system consists of 16 elements. This design of the phased array allows the radar to survey the airspace, detect and track several targets and point several missiles at each of them. The maximum detection range of air targets is 60 km. The battalion command post is also located in a modified BMP-2 chassis. It has a telescopic

an antenna that allows you to organize radio communications with radar stations of batteries and launchers. The complex is in service with the Indian Army.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km: maximum	27.0
minimum	0.5
Damage height, km:	
maximum	15.0
minimum	
Rocket length, m	0.1
Rocket mass, kg	6.5
Maximum rocket speed, M Guidance	660 over
system	3.5 combined: command guidance using a semi-active homing head at the final stage of flight

ADATS
(CANADA)

The ADATS (Air Defense Anti Tank System) anti-aircraft missile system is a multi-purpose all-weather short-range complex that is capable of destroying both air and ground targets. Air targets, including fire support helicopters flying around the terrain,

can be destroyed at very low altitudes.

In June 1986, the ADATS complex was selected by the Canadian Armed Forces as fully satisfying the requirements for short-range air defense systems.

sti.

In 1987, it became one of 4 air defense systems that took part and was recognized as the winner in a competition organized by the US Forward Air Defense Forces Command. The competition included an assessment of the accuracy of detection and tracking of targets carrying out raids according to standard scenarios. Nevertheless, for financial reasons, only 8 ADATS complexes were adopted by the United States.

A modified version of the M113A2 armored personnel carrier was chosen as the running base for the Canadian ADATS complex, and the Brad-MZ combat reconnaissance vehicle was used as the running base for the American complex.

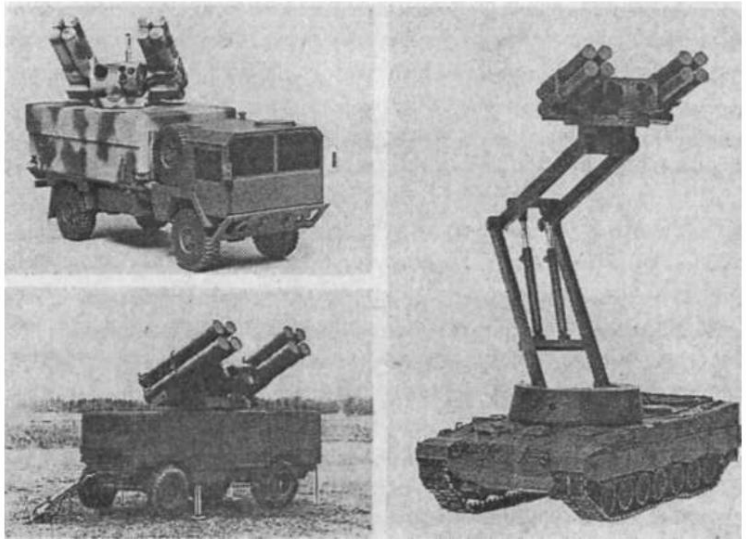
whether." Both chassis provide high maneuverability over rough terrain and protection of the crew from gunfire.

new weapon.

The ADATS complex on the M113M2 chassis is air transportable by the C-130 Hercules aircraft. During numerous tests that took place in various climatic conditions (from -40°C to +70°C), the ADATS complex showed stable operation. In 1994, the ADATS complex proved itself to be excellent during firing at air and ground targets in adverse weather conditions in the Middle East

and Southeast Asia.

It has a high probability of being hit by one missile (over 0.8) when destroying small-sized, low-speed targets at maximum range. The ADATS complex can be integrated with other armored chassis or stationary air defense systems. One of the latest such examples is the integration in 1995 of the ADATS complex with a MOWAG Piranha type chassis (10x10 wheel arrangement). This version of the complex is intended for air defense of airfields, power plants and other important



ADATS air defense missile system deployment options (under development)

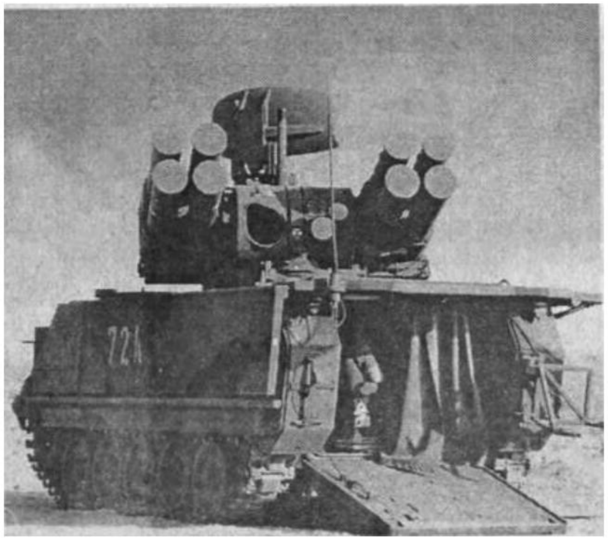
objects. It is planned to use the ADATS complex in a sea-based version of both an independent air defense system and one integrated with other types of air defense.

air weapons.

Pulse-Doppler radar for detecting and tracking targets with pulse frequency tuning has good noise immunity. The radar antenna system forms a two-beam (in a narrow plane) radiation pattern. The transmitter operates in the frequency range 8-12 GHz. The presence of a processor in the computing equipment ensures simultaneous tracking of up to six targets. There is "friend or foe" identification equipment. At a radar rotation speed of 38 rpm, the detection range of air targets is up to 25 km, and at a rotation speed of 57 rpm, the detection range is reduced to 17 km.

Optical-electronic target tracking and guidance unit

The missile's design consists of television and thermal imaging tracking devices, a laser range finder, a guidance device with a carbon dioxide laser, and four IR goniometers. All these means are installed on a gyro-stabilized base in the front of the chassis. Availability of optical



ADATS air defense system in combat position

The electronic unit allows combat crews to detect and track targets in passive mode.

Tracking devices of both types have wide and narrow fields of view (television - 4° and 0.9°, thermal imaging - 9° and 3.2°) and can be used to track both air and ground targets. A television device with high resolution is used during daylight hours under favorable weather conditions, and a thermal imaging device (wavelength range 8-12 microns), developed on the basis of the night vision system of the AN-64A Apache helicopter , - when escorting air targets not only in

dark time, but also in difficult weather conditions.

Each of the eight combat-ready missiles is located in the TPK. The missiles do not require maintenance during storage and loading onto the launcher. Mounted on the tail of the rocket

Two laser radiation receivers have been updated, and there is a solid-fuel smokeless rocket engine. The reloading time for all missiles without the use of special devices

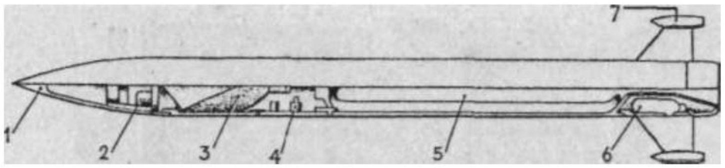
by two members of the combat crew is less than 10 minutes.

The combat operation of the ADATS complex occurs as follows. The radar searches for targets, detection data

married and identified purposes are entered into the computer for

assessing the degree of their threat and determining the sequence of fire. The platform turns in the direction of the target selected for firing, and the operator captures it with a television or thermal imaging tracking device. At the same time, the range to the target is measured with

using a laser rangefinder.

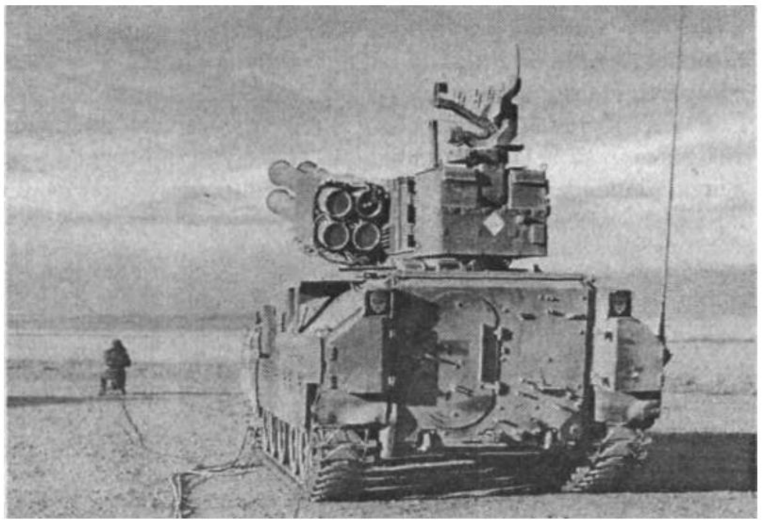


Guided missile of the ADATS complex:

1 - contact fuse; 2 - compartment with electronic control equipment; 3 - cumulative fragmentation warhead; 4 - non-contact fuse; 5 - solid fuel engine; 6 - steering drives; 7 - laser radiation receiver.

When a target enters the affected area of the complex, a missile is launched, the guidance of which is divided into two stages. At the first, it is displayed on the line of sight of the target. In this case, the coordinates of the rocket, measured using IR goniometers, are compared with the parameters of the calculated trajectory entered into the memory of the computer, which generates commands in the form of laser radiation (with time modulation) created by the guidance device, and then transmitted on board the rocket. In the second stage (after stopping the engine), a spatially modulated laser beam is focused on the

target. Laser radiation receivers installed on the tail of the rocket measure the deviation of the latter from the beam axis. The on-board computing device converts them into rudder control commands, during which the missile is held in the center of the laser beam aimed at the target. To detonate a warhead, two types of fuses are used: non-contact and contact. The latter is used when shooting at ground targets. The warhead is capable of penetrating armor up to 900 mm thick.



Deployment of air defense systems on the ground

The ADATS complex, using the C3 (Command, Control and Communication) system, can be combined into a network structure consisting of six complexes. One tactical node is formed, communication in which is carried out using one of 2000 closed frequencies. Such a tactical node allows ADATS complexes to communicate with other radars and

weapons systems, as well as similar tactical nodes.

One of the six ADATS complexes is considered the main one; its commander receives complete information about the coordinates of each complex, as well as the current tactical situation. In addition, the tactical unit includes one or more surveillance radars that provide radar information to all complexes.

The commander of the tactical unit directs the combat work of the complexes, transmits combat orders to them to control weapons, carries out target distribution for each complex through the appropriate communication channels.

Serial production is carried out according to a specific order. 36 ADATS systems are in service with the Canadian Armed Forces. Thailand is armed with a stationary version of the complex, located in a shelter under the control of the Skyguard fire control system. Eight ADATS complexes are in service with the United States.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum	10.0
high-speed targets Maximum	8.0
engagement altitude, km Maximum missile	7.0
speed, M Length, m: missiles missiles	over 3
in TPK	
Missile	2.05
diameter, m	2.20
Wingspan, m Weight,	0.15
kg: missiles missiles	0.27
in TPK	
warhead	51.0
Type of warhead	67.0
	12.5
	fragmentation-cumulative

EUROSAM
(INTERNATIONAL)

The complex from the EUROSAM family (Land, NAVAL) is designed for air defense of mechanized units and troops on the march, as well as air defense cover of important stationary objects from

massive attack of a wide class of air targets, ranging from tactical missiles, all types of aircraft and ending with various unmanned aerial vehicles in all weather conditions, when the enemy uses various high-intensity interference.

The European consortium EUROSAM was formed in June 1989 by Aerospatiale, Alenia and Thomson-CSF Airsys in
for the purpose of creating and promoting the arms market of computers

Lex family FSAF - Forward Surface-to-Air Family of missile systems. The EUROSAM consortium acts as a systemic
integrator of projects for creating sea and land versions of the air defense complex.

The marine version was named EUROSAM NAVAL System. The far border of the affected area of the complex
determined by the type of missiles used, ASTER 15 and ASTER 30 missiles can be used. It has another name - PAAMS (Principle Anti Air Missile System) - and is
assigned for placement on frigates created within the framework of cooperation between the three countries. The frigates are planned to be introduced into the navies of France, Italy and the Royal Navy of Great Britain after 2000. The

PAAMS complex is operational under the conditions of use opponent of intense interference of various types, fights air-to-surface missile carriers, and also destroys anti-ship missiles flying at low altitudes or diving on a ship with high

angles of attack.

The ground-based complex is called EUROSAM Land system and is a medium-range complex (MSAM - Medium Surface-to-Air Missile).

The program for creating complexes of the FSAF family includes a number of innovations, namely, the modular layout of systems to achieve air transportability, minimizing the total number of elements of the complex, the novelty of the technological solutions used to meet the specifications
technical performance of the system, the ability
carrying out modernization of the complex's systems throughout the entire operation cycle, minimal maintenance of the complex's equipment by combat crew members during its operation
luatations.

All systems included in the FSAF family of complexes consist of replaceable elements that satisfy the above requirements.

The complex consists of:

- multifunctional radar type Thomson-CSF ARABEL or Alenia EMPAR
- ASTER 15 or ASTER 30 missiles;

• land-based or sea-based launchers; • computer systems operating in real time MARA (Modular Architecture for Real-time Applications);

• systems for displaying graphic and video information MAGICS (Modular Architecture for Graphic and Image Console Systems); • software written in the ADA programming language. The complex includes the ASTER 30 missile, launchers with vertical launch of missiles (LMs - Launcher Modules) and a combat control cabin - FCU (Fire Control Unit). The ASTER 30 missile has a PIF-PAF (lateral impulse control - aerodynamic flight control) guidance system. The launch accelerator accelerates the rocket to maximum speed, and then it is captured for tracking. On co-

During the final part of the flight, the missile is aimed at the target interception point using a radar guidance system. The combat control cabin (FCU) includes: • multifunctional ARA-BEL MFR PAC mounted on the chassis (it includes a phased antenna relay)

grid, transmitter, power system, equipment for receiving and processing the received signal); • a protected cabin for two combat crew members (EM - Engagement Module), which houses the above-mentioned computer systems equipment, operating in real time and processing all information about the target being destroyed, as well as two consoles with MAGICS display systems. The ARABEL multifunctional radar allows for all-round surveillance of space, detection and tracking of targets, as well as guidance of missiles at a target to be destroyed by transmitting control commands to its board. The implementation of such a multifunctional mode of operation of the RAS is ensured by powerful computing tools -

mi complex.

The RAS scans the azimuthal space in a circular manner and from 0° to 70° in the elevation plane during one

rotation of the antenna blade, carried out in 1 s. The electron beam dimensions are 2°. ARABEL ASD is characterized by We have a high degree of control over radiation modes, instant tuning of the frequency of the probing signal, adaptive processing of the received reflected signal and different times of target irradiation, narrow dimensions of the probing beam, etc. The combat control cabin allows you to control 4-6 launch modules, mounted on the chassis. Each launch module contains 8 combat-ready missiles of the ASTER 30 type. The ASTER 30 missile defense system and the ASTER 15, which is being developed simultaneously for the ship version, are solid-fueled.

shower rockets and differ only in starting boosters. The missiles are equipped with an active radar seeker operating in the frequency range 10-20 GHz. It is a modification of the homing head of the MICA air-to-air guided missile. The diameter of the seeker is 0.18 m, the length (including the electronic guidance equipment unit) is 0.6 m. Guidance of the missile over most of its trajectory

flight to the target is carried out through a command-inertial system, and homing using information received from the seeker occurs only in the final section. In this case, it is provided that the search and capture of the target by the head is carried out during the flight of the rocket. The ASTER 30 missile defense system uses a combined flight control system, in which, along with aerodynamic

The control surfaces are solid-fuel micromotors with radial (relative to the rocket body) orientation of the nozzles. They are located near the center of mass of the missile defense system. The use of a combined flight control system allows the rocket to maneuver with an overload of up to 40 units. The structure of the multifunctional RAS can be supplemented with a “dead crater” surveillance system of the ZEBRA Zenithal type, which provides detection of dive missiles, and a state identification system (IFF/NIS), which is integrated with the multifunctional RAS or has its own emission and reception path

signal.

Typical battery of a ground-based complex EURO-SAM Land consists of a combat control cabin, multifunctional

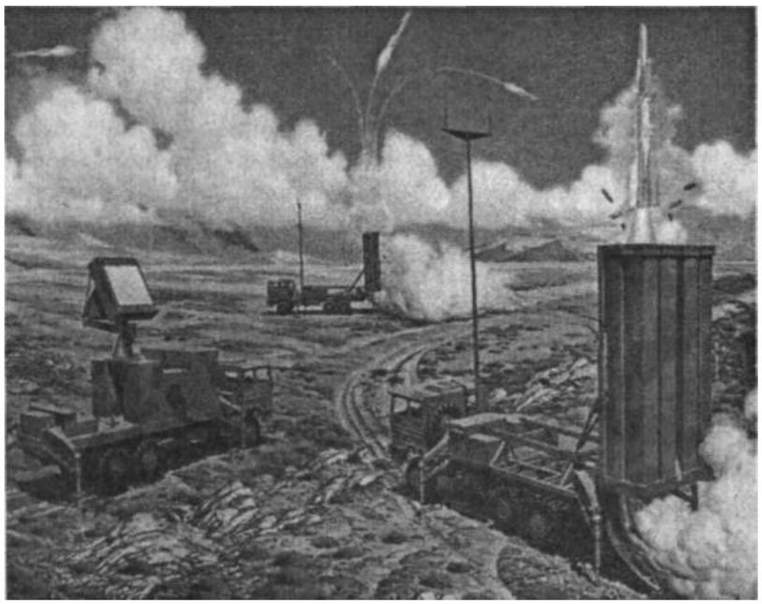
national radar and ZEBRA Zenithal (ZR) radar, located at a distance of up to 500 m, and b launchers, located at a distance of 10 km from the control cabin. The work of all subsystems is carried out by two members of the combat crew. Possible integration into

a complex of other optoelectronic reconnaissance equipment.

The type of chassis, power supplies, communications equipment and special equipment that provides coded transmission of information can be selected at the request of the user.

specific customer.

Typically, the combat operation of the EUROSAM LAND complex proceeds as follows. When an alarm signal is announced, the combat control cabin operators bring all elements of the complex into a combat position, ensuring their power supply. The antenna of the ARABEL multifunctional radar rotates at a speed of 1 rpm, thereby providing a circular view of the airspace in the azimuthal plane and from 0° to 70° in elevation. Viewing the elevation plane at angles greater than 70° is provided by the ZEBRA ZR radar. If necessary, a multifunctional radar can be



EUROSAM SAM ORDER OF BATTLE

Sectors of responsibility have been assigned that have priority in detecting and firing at detected targets. In these sectors, the target is detected and identified in one rotation of the antenna

are obtained by additional probing of the area of space where the target was initially detected. If, during repeated probing, confirmation of target detection occurs, then with the next rotation of the antenna, its path is connected. Information about the target track enters the combat control cabin and is displayed on the displays. Computing means prolong the future

marks taking into account the expected movement of the target, its speed and nature of movement. Each goal is assigned an individual number (there is a sign of one's own and someone else's goal). When the target enters the launch zone of the complex, the combat control cabin

tion issues commands to the corresponding launchers

new, these commands are used to prepare for the launch of one or two ASTER 30 missiles. Next, the combat control point issues commands to launch

one or two missiles. At the launcher, after receiving the start command, information about the direction and other movement parameters is transmitted to the rocket

target, as well as the value of the missile's declination angle during its vertical launch. Accordingly, preparations are underway to capture launching missiles for escort. Then the rocket launches vertically and leaves its transport and launch container. The operating modes of the phased array antenna of the multifunctional radar make it possible to detect and track a launched ASTER 30 missile, then its path is formed using computational means. After leaving the transport and launch container, the missile inclines in the direction of the intended meeting point with the target.

At the combat control point, the missile path is displayed on indicators. The coordinates of the target and the parameters of its movement are updated in a second and transmitted on board the missile to guide it to the expected meeting point. After the rocket accelerator has finished operating, the main engine starts with a certain time delay. The rocket's flight path is formed in this way:

So that its approach to the target allows the target to be captured by the missile's homing head, which is activated at a certain point on the flight path.

After the main engine has finished operating, the rocket continues to fly towards the target. The rocket's rudders and wings are used to control the flight; if necessary, a PIF guidance system (lateral impulse control) is used at the final stage of the flight in order to minimize misses and cause maximum damage to the target. The ASTER 30 missile is equipped with a high-explosive fragmentation warhead

with a programmable delay in the activation of a proximity fuse.

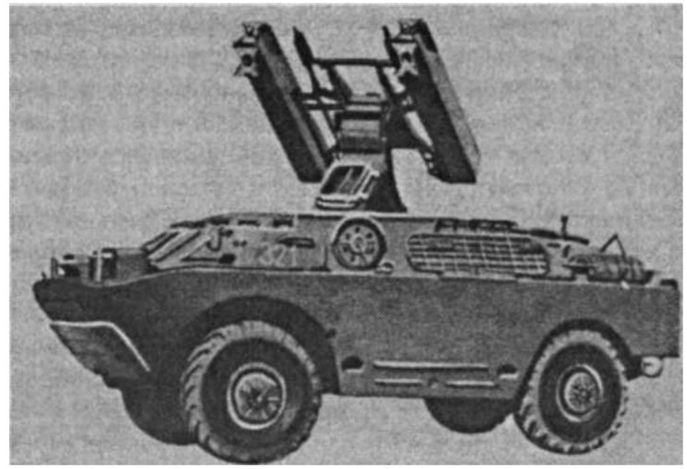
Each battery can simultaneously fire 16 missiles at various targets. Information about the number of spent and combat-ready missiles on each launcher is used during combat operations when assigning new missiles to fire at newly discovered targets. The mobility of the complex is ensured by its air transportability.

TACTICAL AND TECHNICAL CHARACTERISTICS

Maximum engagement range, km:	
missiles	10.0
aircraft	30.0
loitering jammers Length, m:	to 80.0
rocket launch accelerator	2.3
	2.7
Diameter, m:	
rocket	0.18
launch accelerator Launch	0.38
mass, kg: rocket launch	
accelerator Maximum	350.0
rocket	100.0
speed, m/s	1100—1400

"Strela-1"

(RUSSIA)



The Strela-1 anti-aircraft missile system (SA-9 Gaskin) is designed to destroy air targets flying at speeds up to 310 m/s at ranges up to 4.2 km, at an altitude of 50-3500 m. The complex is self-propelled, all-weather, mounted on a BRDM-2 chassis, capable of firing at targets from

places and on the move.

Development of the complex began in August 1960. OKB-16 GKOT was appointed the lead developer of the complex and the missile defense system, which was later transformed into the Precision Engineering Design Bureau (KBTM) MOP. Chief designer A.E. Nudelman.

Initially, in accordance with the TTT, the 3PK was supposed to hit targets at ranges of up to 2 km and at altitudes of up to 1500 m, since it was planned to use the Strela-1 missile for the portable version of the complex. However, later a decision was made to use the air defense system only on a vehicle chassis and, accordingly, a requirement was put forward to increase the target engagement range to 5 km and the maximum altitude to 3.5 km. This required increasing the size and mass of the rocket.

I When developing the Strela-1 9K31 complex, it was decided] use not an infrared (thermal) seeker on a rocket, but a photo-contrast seeker. This was due to the low sensitivity of infrared seekers, which do not provide target identification in the front hemisphere, and therefore shooting at self-

enemy flights could only be carried out "in pursuit", as usual Well, after they completed their combat mission. In such tactical conditions, it was quite possible to destroy the air defense system even before launching anti-aircraft missiles. The use of a photocontrast seeker made it possible to fire at targets on a collision course. V. A. Khrustalev was appointed the chief designer of the optical homing head for the missile defense system, and the development organization was TsKB-589 GKOT. State tests of a prototype of the Strela-1 complex were carried out in 1968 at the Donguz test site. In April 1968, the complex was put into service.

The Strela-1 complexes were part of a platoon (four combat vehicles) in an anti-aircraft missile and artillery battery (Strela-1 - Shilka) of a motorized rifle (tank) regiment. The 9A31 air defense missile system combat vehicle is equipped with a launcher with four missile defense systems placed on it in transport and launch containers, missile defense launch equipment, optical detection and aiming means, as well as

mi connections.

The complex is capable of firing at airplanes and helicopters flying at altitudes from 50 to 3000 m at speeds of up to 310 m/s on a head-on course and up to 220 m/s on a catch-up course with course parameters up to 3000 m, as well as at hovering helicopters -flying and drifting balloons. The capabilities of the photocontrast seeker allow firing only at visually observable targets against the background of a clear sky or continuous cloud cover at angles between the directions to the target and to the sun of more than 20° and when the angular elevation of the target line of sight above the visible horizon is more than 2°. Dependence on target illumination, weather conditions and background conditions limits the combat use of the Strela-1 complex. However, average statistical estimates of this dependence, taking into account the possibility of enemy aviation operations in the same conditions,

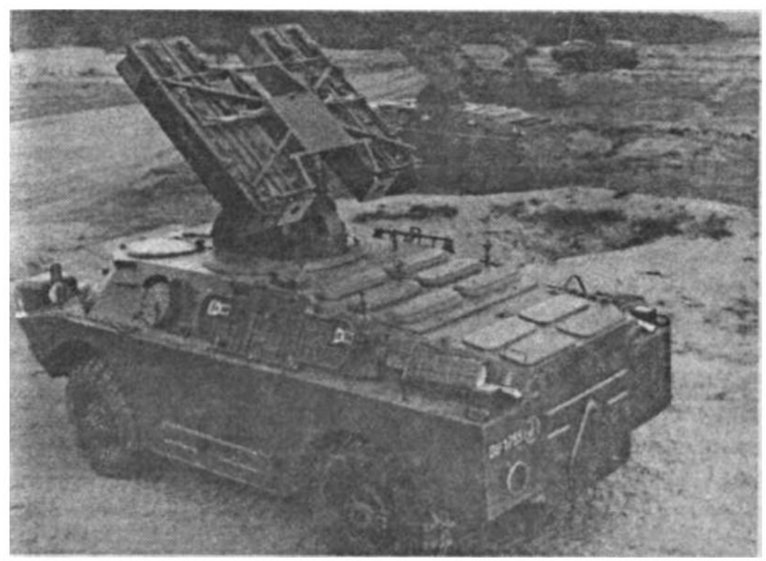
as well as the practical application of the complex during exercises in

war conflicts showed that the Strela-1 air defense system could be used quite effectively (in terms of military-economic indicators).

Aiming the launcher at the target is carried out by the muscular efforts of the operator. Using a system of lever-parallelogram devices, he uses his hands to move the launch frame with missiles, the lens of the optical sighting device and the rough sight, connected to each other, to the required elevation angle (in the range from -5° to +80°), and with his feet, mediation

number of knee supports connected to the seat, all around directs the launcher in azimuth, starting from the cone attached to the floor of the machine. The front wall of the operator's tower in the 60° sector in azimuth is made of transparent bullet-resistant glass. In the transport position, the launcher is lowered to the roof of the combat vehicle.

Shooting in motion is ensured due to the almost complete natural balance of the swinging part and the alignment of the center of gravity of the launcher with missiles with the point of intersection of the machine's swing axes due to the ability of the human operator to fend off low-frequency vibrations of the machine body.



SAM "Strela-J" in combat position

The 9M31 anti-aircraft guided missile is made according to the canard aerodynamic design and is aimed at the target using a seeker using the proportional navigation method. The seeker converts the radiant energy flow from a target contrasting against the sky into an electrical signal containing information about the angle between the axis of the seeker coordinator and the missile-target line of sight, as well as the value of the angular velocity of the line of sight. Uncooled lead-sulphide photovoltaics are used as sensitive elements in the seeker.

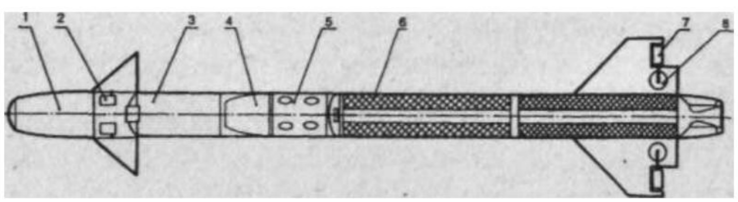
resistance.

Behind the seeker, the steering drive of triangular aerodynamic rudders, control system equipment, a warhead and an optical fuse are successively located. Next, a solid propellant rocket engine is installed on the tail

in the compartment of which the trapezoidal wings of the cancer are fixed

You. The rocket uses a single-chamber, dual-mode solid-fuel rocket engine. At the launch site, the rocket accelerates to a speed of about 420 m/s, which is then maintained relatively constant during the cruising stage. The rocket is not roll stabilized. In the event of a direct hit on the target, a contact magnetoelectric sensor, and in the event of a missile flying close to the target, a non-contact electrode

ron-optical sensor, undermines the warhead of the missile defense system. In case of a large miss, the safety-actuating mechanism is removed from the combat position after 13-16 s and can no longer detonate the warhead. When falling to the ground, the missile defense system does not explode - . does not change, but only becomes deformed, without causing significant damage to its troops.



Layout of the 9M31 missile for the Strela-G air defense system:

1 - photocontrast seeker; 2 - steering gear; 3 - on-board equipment; 4 - combat unit; 5 - non-contact fuse; 6 - solid propellant rocket engine; 7 - roller skates; 8 - roller rotor .

The 9M31 missile is stored, transported in a transport and launch container and launched directly from it. The 9YA23 transport and launch container protects the missile from contamination and mechanical damage. It is attached to the PU frame.

When receiving target designation or when independently visually detecting a target, the gunner-operator points the launcher with a missile defense system at the target, using an optical sight to improve accuracy. At the same time, the power supply of the first missile defense system is turned on (after 5 seconds, the second missile defense system is turned on) and the covers of the transport and launch containers are opened. Having heard the sound signal that the seeker has captured the target and visually assessed the moment the target enters the launch zone, the operator launches the missile. When the missile moves through the container, the electrical power cable of the missile defense system is cut off, and the first stage of protection in the safety-actuating mechanism is removed. Shooting is carried out according to the “shoot and forget” principle.

In the period from 1968-1970. The complex was modernized. A passive direction finder (PDF) was introduced into the air defense system, which ensures the detection of targets with on-board radio equipment turned on, their tracking and insertion into the field of view of the optical sighting device. It is possible to target according to the data of an air defense system with a passive direction finder by another air defense system "Strela-1" of a simplified configuration - without direction finder.

Thanks to improvements to the rocket, the range has been reduced border of the complex's destruction zone, the probability of hitting targets at low altitudes and homing accuracy are increased. A control and testing machine has been developed that makes it possible to monitor the operation of standard combat weapons of the Strela-1 complex, taking into account the changes introduced into it during modernization. Tests of the Strela-1M complex were carried out at the Don-Guz test site from May to July 1969. The Strela-1M air defense system was accepted into service with the air defense forces of the North Army in December 1970.

As a result of modernization, the near border of the affected area is closer, the lower border of the affected area is reduced -

up to 30 m. The probability of hitting maneuvering and non-maneuvering targets has increased. The combat

operation of the Strela-1M air defense system had some features compared to the autonomous operation of the Strela-1 complexes. All complexes in the platoon are oriented on the ground in a single coordinate system for the Strela-1-Shilka anti-aircraft missile and artillery battery. Radio communication is maintained between combat vehicles. The air defense system commander monitors the radio technical situation in the coverage area of the passive direction finder using all-round light and sound indicators. When light and sound signals appear, the commander assesses the state order

the identity of the target and, after making a decision about whether the signal belongs to the radar of an enemy aircraft, via internal communication, informs the operator of his combat vehicle, the battery commander and the rest of the combat vehicles of the air defense missile system platoon of the direction to the target. The battery commander carries out target distribution between the combat vehicles of the SAM and ZSU platoons. Having received information about the target, the operator turns on the precision direction finding system, deploys the launcher towards the target and, making sure that the signal belongs to counter-measures Nika, with the help of synchronous signals on the light indicator and in the headset, follows the target until it enters the field of view of the optical sight, and then points the launcher with missiles at the target. The starting equipment is set to “automatic” mode. When the target approaches the launch zone, the operator turns on the “board” button, applying voltage to the missile defense board, and launches it. The “forward-backward” operating modes provided in the complex allow the operator

depending on the type, speed and position of the target relative to the complex, fire towards or chase. So, when launching in pursuit of all types of targets, as well as when launching towards a low-speed target (helicopter)

“Back” mode is set.

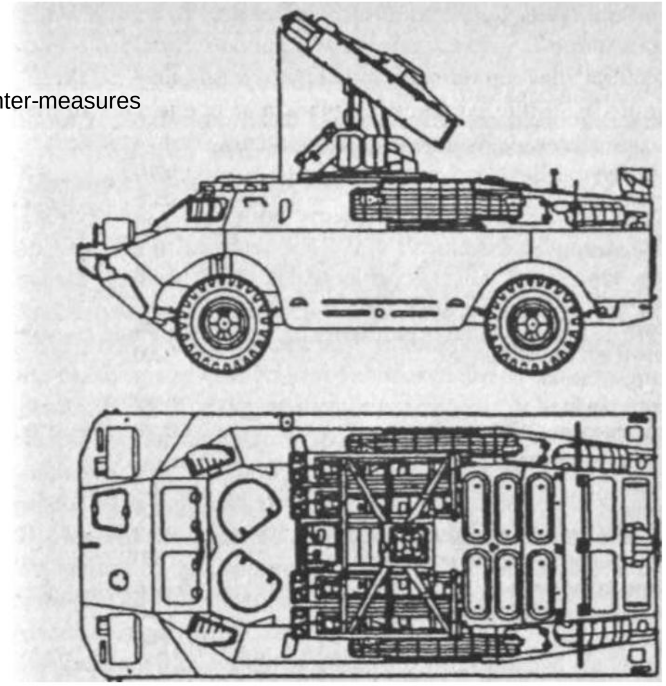
The battery is controlled by the regiment's air defense chief through the PU-12 (PU-12M) automated control points available to him and the battery commander. Commands, orders and target designation data on the Strela-1 air defense system from PU-12 (PU-12M), which is the battery commander’s

point, are received through communication channels formed with the help of radio stations.

The first combat use of the complex was noted in May 1981. against Israeli aircraft flying over Lebanese territory. However, no evidence of target destruction was noted in this case, and the complexes themselves were subsequently destroyed as a result of Israeli air raids. In 1982, the Israelis captured one combat vehicle of the Stre-la-1 air defense system in Lebanon in the Bekaa Valley. In December 1983, a US Navy A-6E was shot down by a Syrian Strela-1 air

defense system. In the same raid, an A-7E Corsair was shot down, presumably by joint fire from the Strela-1 air defense system and the Strela-2 MANPADS. Iraq used the Strela-1 air defense system against Iran and forces

coalition during the Gulf War.



One combat vehicle, along with missiles, was captured by the South African Army during the fighting in Angola in 1983, after several missiles were launched at South African Air Force aircraft carrying out bombing and reconnaissance flights. Another 15 launchers were captured later.

The complex was supplied to the following countries: Angola (more than 20 air defense systems), Algeria (more than 40), Benin (4), Bulgaria (50), Hungary (28), Vietnam, Egypt (20), Iraq, Cuba (60) , Libya (60), Mozambique, Mauritania, Nicaragua, Poland (200), Romania (more than 40), Syria (more than 40), Tanzania, Slovakia, Czech Republic, Croatia, Ethiopia.

TACTICAL AND TECHNICAL CHARACTERISTICS

	"Strela-1"	"Strela-1M"
Damage range, km:		
maximum	4.2	4.2
minimum	1	0.5
Damage height, km:		
maximum		3.5
minimum	3	0.03
Maximum target parameter, km 3.5 Probability of hitting a fighter 1 missile defense system 0.1—0.6 0.1—0.7 Maximum speed of targets hit, m/s: to meet in pursuit Maximum missile speed, m /s Reaction time, s	0.05 3	
Crew,	310	310
people.	220	220
Weight, kg:	420	420
	8.5	8.5
	3	3
missiles	30	30.5
missile warhead Missile	2.6	2.6
length, m Missile	1.8	
diameter, m SAM	0.12	1.8
wingspan, m Dimensions of	0.36	0.12 0.36
combat vehicle, m:		
length	5.8	5.8
width	2.4	2.4
height in transport position Maximum speed	2.3	2.3
on road, km/h Armor thickness, mm Maximum	100	100
speed on water, km/h	5—14	5—14
Cruising range, km	10	10
	750	750

"Strela-10"

. (RUSSIA)

The self-propelled anti-aircraft missile system is designed for destroying airplanes, helicopters and others visually observed air targets at low altitudes.

Work on the creation of the Strela-YUSV (SA-13 Gopher) complex began in 1969. The development of the complex was carried out on the basis of the Strela-1 air defense system.

The Design Bureau of Precision Engineering (KBTM) was appointed as the lead developer of the complex as a whole, as well as the 9M37 missile, missile launch equipment and test vehicle, with A.E. Nudelman as the chief designer. The lead organization for the development of the seeker and proximity fuse of the missile defense system is the Central Design Bureau "Geo-Physics", the chief designer is D. M. Khorol.

The research institute of electronic devices, the Leningrad Optical-Mechanical Association (LOMO), the Kharkov Tractor Plant (KhTZ), the Saratov Aggregate Plant, and the Poisk Research Institute took part in the development of the complex.

Tests of the Strela-YUSV air defense system were carried out from January 1973 to May 1974 and showed that the complex was not fully operational

meets the technical specifications requirements. Therefore, the complex was put into service only in March 1976 after modifications were carried out. The

9K35 air defense systems are organizationally united into the Strela-YUSV anti-aircraft missile platoon of the anti-aircraft missile and artillery battery (the Strela-YUSV air defense missile system platoon and the Tun-Guska complex platoon) of the anti-aircraft division of a motorized rifle (tank) regiment. The platoon consists of one 9A35 combat vehicle and three 9A34 vehicles. The PU-12 (PU-12M) command post was used as a battery command post, which was later supposed to be replaced by a unified battery command post "Rangier".

It was proposed to carry out centralized control of the Strela-YUSV complexes as part of a battery and an anti-aircraft division of the regiment in the same way as the Tunguska complexes - by transmitting commands and target designations from the battery command post and the air defense command post of the regiment via radio telephone (before equipping the air defense missile system with data transmission equipment) and via radio telecode (after such equipment).

Unlike the Strela-1M air defense system, the 9K35 complex was placed not on a BRDM-2 wheeled vehicle, but on an MT-LB tracked multi-purpose tractor, the carrying capacity of which made it possible to increase the transportable ammunition load from four to eight missiles in the TPK (four on guides starting device and four in the self-propelled body). At the same time, it required a long period of development of the combat vehicle’s instrumentation, which was affected by powerful vibrations of the tracked chassis, which were unusual for previously used wheeled vehicles. The Strela-YUSV air defense system used an electric launcher drive

kovy device.

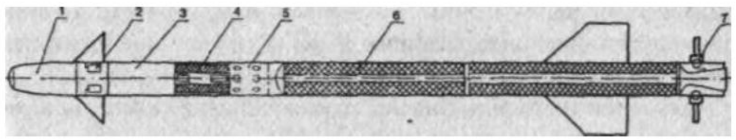
The 9M37 missile of the Strela-YUSV complex includes a two-color homing head. In addition to the photocontrast channel used in the Strela-Sh air defense system, a thermal (infrared) channel was also used, which increased the combat capabilities of the air defense system when firing towards and after the target, as well as in conditions of interference. The photo channel is also used as a backup, since, unlike the thermal channel, it does not require cooling, which could only be provided with a single pre-launch preparation of the missile defense system.

To limit the missile's roll speed, the missile defense system uses free-standing roller-ons located behind the wings.

While maintaining the body diameter and wingspan of the Strela-1 missile defense system, the length of the 9M37 missile was increased to 2.19 m. To increase the effectiveness of the combat equipment while maintaining the same mass (3 kg) of the high-explosive fragmentation warhead, rod-based (cutting) damaging elements.

The 9S86 launch zone assessment equipment was introduced into the Strela-YUSV complex, which automatically generates data for working out the required lead angles. This made it possible to launch missiles in a timely manner. It is based on a coherent-pulse radio range measure of the millimeter wave range, which provides determination of the range to the target (ranging from 430 to 10,300 m with an error of no more than 100 m) and the radial speed of the target (with an error of no more than 30 m/ c), as well as an analog-discrete computing device that determines the boundaries of the launch zone with maximum errors of 300-600 m and lead angles during launch with average errors of 0.1-0.2°.

The Strela-YUSV complex now has the ability to fire at faster targets compared to the Strela-1M air defense system, and the boundaries of the affected area have expanded. If the Strela-1M complex was not protected from either natural or organized optical interference, then the Strela-YUSV air defense system, when operating using the thermal channel of the seeker, is protected from natural interference and, to a certain extent, from



Layout of the 9M37 missile defense system "Strepa-10":

1 - combined seeker; 2 - steering gear; 3 - on-board equipment; 4 - combat unit; 5 - non-contact fuse; 6 - solid propellant rocket engine; 7 - roller skates.

single intentional optical interference traps. However, the Strela-YUSV air defense system still had many limitations on effective shooting using both photocontrast and thermal channels of the seeker of the missile defense system. In 1977, the Stre-la-USV complex was

modernized. The seeker of the missile defense system and the missile launching equipment for the 9A34 and 9A35 combat vehicles were improved. The complex was named “Strela-YUM” (9K35M).

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The seeker of the 9M37M missile, based on trajectory characteristics, can select targets and organized optical interference, which made it possible to reduce the efficiency of thermal fur traps.

In all other characteristics, the 9K35M complex is similar to the Strela-YUSV complex, with the exception of a slight increase (by 2-3 s) in working time when firing in conditions from interference.

Tests of the 9K35M air defense system were carried out from January to May 1978. The Strela-YUM complex was put into service in 1979. In 1979-1980. further modernization was carried out tion of the Strela-YUM complex.

During its implementation, the combat vehicles of the complex were equipment for automated reception of target designation 9V179-1 was introduced from the PU-12M battery command post and the command post of the air defense chief of the PPRU-1 regiment (Ovod-M-SV) or from detection radars equipped with ASPD-U equipment, as well as equipment for testing target designation, which ensured automated pointing of the launcher to the target. The set of combat vehicles of the complex included the addition of folding panels from the sides of the combat vehicles.

swimming trunks made of polyurethane foam to overcome water obstacles by swimming with a full ammunition load of missiles and a machine gun, as well as an additional radio station R-123M to ensure the reception of telecode information.

Field tests of a prototype of the complex, which received the name “Strela-YuM2” (9K35M2), were carried out in July-October 1980.

As a result of the tests, it was found that in a given affected area using an automated emulation and testing of the control center (when homing missiles using photocontacts

direct channel without interference) the air defense system ensures the firing efficiency of one missile defense system at fighters on collision courses, amounting to 0.3 at a range of 3.5 km and 0.6 in the range range from 1.5 km to the near border of the zone, which is - increased the firing efficiency of the Strela-YUM complex by 0.1-0.2 at the same ranges. This was achieved by increasing the target detection range from 6.8 to 8.4 km, reducing operating time at the control center from 8.5 to 6.5 s, increasing the frequency of target denial from 0.7 to 1, reducing time bringing the control center to the operator (2.5 times) and practicing target designation (2 times).

In 1981, the Strela-10M2 complex was put into service. In the period 1983-1986. under the code “Kitoboy” the modernization of the Strela-YUM2 air defense system was carried out. It was carried out by a cooperation of enterprises that developed the Strela-10 air defense system.

Compared to the Strela-YUM2 air defense system, the modernized complex was supposed to have a larger affected area and have higher efficiency and noise immunity.
efficiency in conditions of intense organized optical interference, ensure firing at all types of low-flying air targets (airplanes, helicopters, cruise missiles, remotely piloted vehicles).

Battery command post PU-12M

Joint tests of the prototype of the "Kitoboy" air defense system were carried out from February to December 1986. In 1989, after the modification of the 9MZZZ missile defense system, it was adopted by the Soviet Army under the name "Sgrela-YuMZ" 9K35MZ.

Combat vehicles included in it are 9A34MZ and 9A35MZ had a new optical sight with two channels with variable field of view and magnification factor: wide-field high-field - with a field of view of 35° and a magnification of 1.8x and narrow-field - with a field of view of 15° and a magnification of 3.75x (provided an increase in the detection range of small targets by 20-30%), as well as improved missile launch equipment, which allowed carry out more reliable target acquisition by the missile seeker. The new 9MZZZ missile system, compared to the 9M37M missile, has a slightly modified engine and container, as well as a new seeker with three

receivers in different spectral ranges: photocontrast, infrared (thermal) and jamming with logical target selection against the background of optical ones

interference based on spectral and trajectory characteristics, which means significantly increased the noise immunity of the complex.

The new autopilot ensured more stable operation of the seeker and the missile defense control loop as a whole in various missile launch and flight modes, depending on the interference (background) situation.

The new non-contact fusing device of the missile defense system is made on the basis of four pulsed laser emitters, an optical circuit that forms an eight-beam diagram

directionality, and the receiver of signals reflected from the target. The number of beams doubled compared to the 9M37 missile system increased the effectiveness of hitting small targets.

The warhead of the 9MZZZ SAM has an increased weight (5 kg instead of 3 kg in the 9M37 SAM) and is equipped with rod striking elements of a larger cross-section and longer length. Due to increasing the bursting charge increases the expansion speed fragments.

The contact fuse consists of a safety-detonating device, a triggering device for the sanitizer mechanism liquidation, contact target sensor and transmission charge.

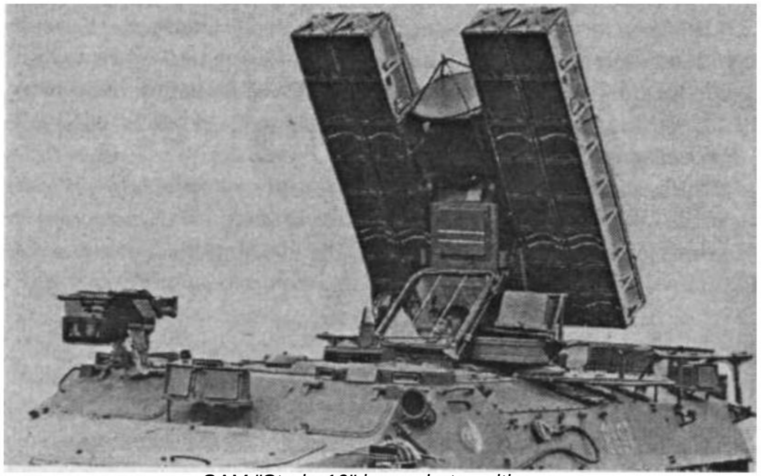
In general, the 9MZZZ missile system is much more advanced than the 9M37 missile, but did not meet the requirements for performance at high temperatures [up to 50 ° C) and for hitting small targets on intersecting courses, which required its modification upon completion of joint tests. The length of the rocket has been increased to 2.23 m.

9MZZZ and 9M37M missiles could be used in all modifications of the Strela-10 complex.

The 9K35MZ complex ensures, with optical visibility, the destruction of tactical aircraft, helicopters, as well as remotely piloted aircraft (RPA) and cruise missiles in conditions of natural interference, and

also airplanes and helicopters in the conditions of their use organized optical interference.

The complex provides a zone and probability of destruction no less than that of the 9K35M2 air defense system at altitudes from 25 to 3500 m aircraft flying on collision courses at speeds up to 415 m/s (up to 310 m/s - in pursuit), and helicopters with flight speeds up to 100 m/s. Cruise missiles with speeds of up to 200-250 m/s and UAVs with speeds of 20-300 m/s are hit at altitudes from 10 to 2500 m (in the photocontrast channel - only above 25 m). Range and probability of hitting targets such as an F-15 fighter flying at a speed of 300 m/s, at



SAM "Strela-10" in combat position

when firing towards at altitudes and with heading parameters up to 1 km, when an aircraft was shooting upward at a rate of 2.5 s, optical interference was reduced to 65% in the photocontrast channel and, accordingly, to 30 and 50% in the thermal channel (instead of the reduction allowed according to TTZ by 25%). In the rest of the affected area, as well as when shooting down interference throughout the entire area, the reduction in ranges and probability of destruction does not exceed 25%.

In the 9K35MZ complex, it became possible to ensure reliable target acquisition by the homing head of the 9MZZZ missile before launch in the presence of optical interference. The functioning of

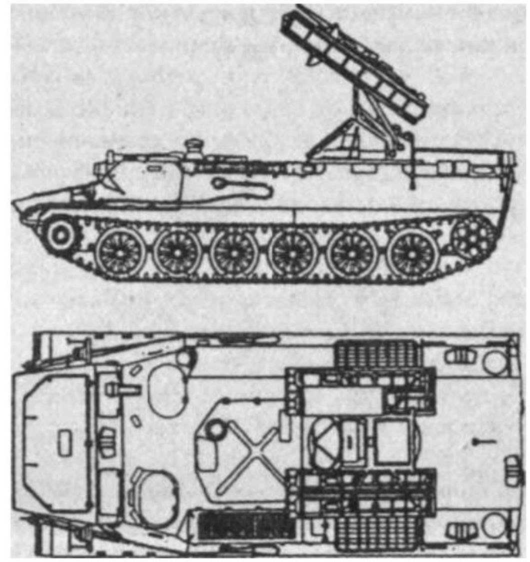
the complex was ensured by the use of a 9V839M inspection and testing machine, a 9V915 maintenance machine and a 9I111 external power supply system.

Serial production of combat vehicles of all modifications of the Strela-YUSV complex was organized at the Saratov Aggregate Plant, and missiles at the Kovrov Mechanical Plant

factory

The Strela-YUSV air defense systems were supplied to a number of foreign countries and were used in military conflicts in the Middle East and Africa. The complex was used during combat operations in Chad (together with Libyan forces) and in Angola with the MPLA and Cuban forces. In both cases, the air defense systems were captured by pro-Western enemy forces. During 1987-88. in Angola, with the help of Strela-10, a Mirag-F-1AZ fighter-bomber of the South African Air Force was shot down. The complex also took part in the Gulf War in 1991.

The complex was supplied to the following countries: Afghanistan (16 air defense systems), Algeria (32), Angola (10), Bulgaria (10), Hungary (4), India (45), Iraq, Jordan (50), Cuba (40), Libya (60) Poland (60), Syria (20), Slovakia, Czech Republic, Croatia, South Africa



TACTICAL AND TECHNICAL CHARACTERISTICS OF THE STRELA-10 SAM

	"-10SV"	-YUM"	"-10M2"	"-10MZ"
Damage range, km:				
maximum				
minimum	5 0.8	5 0.8	5 0.8	5 0.8
Damage height, km:				
maximum	3.5	3.5	3.5 3.5 0.025	
minimum	0.025 0.025 0.025 up to 3 up to 3 up to 3			
Parameter, km		until 3		
Probability of damage				
fighter of one missile defense system	0.1—0.5 0.1—0.5 0.3—0.6 0.3—0.6			
Maximum speed of targets hit (toward/after), m/s				
Reaction time, s SAM flight speed, m/s Weight, kg:	415/310 415/310 415/310 415/310 6.5 8.5 6.5 7 517 517 517 517			
missile	40	40	40	42
warhead				
Number of missiles on a combat vehicle	3 8	3 8	3 8	5 8

"Wasp"

(RUSSIA)

The self-propelled anti-aircraft missile system "Osa" (SA-8 "Gesko") is designed to cover the forces and assets of motorized rifle divisions from low-flying targets. Its development began in 1960 and was not easy. During the long-term creation of the Osa air defense system, both the main designers of the system as a whole and the developers of individual components (chassis of self-propelled guns, missiles) changed. The formation of the concept for building the Osa air defense system was influenced to a certain extent by information about work

being carried out in the United States to create an autonomous self-propelled air defense system "Mauler" with

placement of all its means - on the chassis of a widely implemented in those years, the M-113 tracked multi-purpose armored personnel carrier (APC). However, the Americans never managed to create this complex.

For the first time, the task was set to develop an autonomous computer lex with placement on one self-propelled floating chassis (combat vehicle) as all combat assets, including radio location stations and a launcher with missiles, so and means of communication, navigation and topographical reference, control, as well as power supplies. The requirements for detecting air targets in motion and hitting them were also new. them with fire from short stops.

The domestic complex was put into service in October 1971, at the same time the Osa-M air defense system entered service with Navy ships. The Osa air defense system (9KZZ) consisted of a

9AZZB combat vehicle with reconnaissance, guidance and launch equipment with four 9MZZ anti-aircraft guided missiles, a 9T217B transport-loading vehicle (TZM) with eight missiles, as well as control and maintenance equipment mounted on vehicles.

The combat and transport-loading vehicles were placed on a three-axle BAZ-5937 chassis, equipped with a water cannon for movement afloat, powerful running diesel engine - lem, means of navigation, topographical reference, life support, communications and power supply of the complex (from the gas turbine unit and from the power take-off generator of the propulsion engine). The driver's compartment is located at the front of the chassis and consists of two workstations - the driver and the commander. The complex is air transportable by Il-76 aircraft.

The target detection radar located on the 9AZZB combat vehicle was a coherent-pulse all-round radar of the centimeter range with an antenna stabilized in the horizontal plane, which made it possible to search and detect targets while the complex was moving. The radar carried out a circular search by rotating the antenna at a speed of 33 rpm, and according to the elevation angle - by throwing the beam to one of three positions with each rotation of the antenna. With a pulsed radiation power of 250 kW, a receiver sensitivity of the order of 10- beam in azimuth of 1°, in elevation angle from 4° in the two lower positions of the beam and up to 19° in the upper position (the total viewing sector in elevation was 27°), the station detected -the fighter lived at ranges of 40 km at a flight altitude of 5000 m (27 km at an altitude of 50 m). The ^{10} W, width station was well protected from active and passive interference. During transportation, the antenna sheet is folded at an angle of 90°. According to NATO terminology, the station received the code name “Land Role”.

A centimeter wave target tracking radar installed on a combat vehicle with a pulse radiation power of 200 kW, receiver sensitivity of 2x10_13W and

a beam width of 1° ensured target acquisition for auto-tracking at ranges of 23 km at a flight altitude of 5000 m and 14 km at a flight altitude of 50 m. The standard deviation of target auto-tracking was 0.3 d.u. (protractor divisions, i.e. 0.06°) in angular coordinates and 3 m in range. The station had a moving target selection system and various means of protection against active interference. With strong active

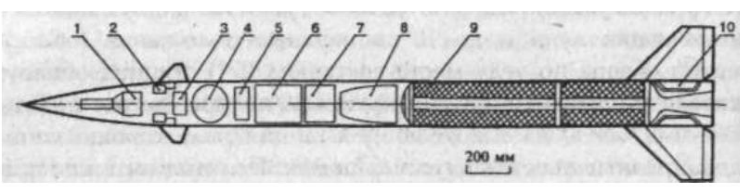
interference, it is possible to follow with the help of television
-optical viewfinder and detection radar. It is known that the

existing two missile guidance radars operate at separate frequencies, each with only one missile, thereby increasing the noise immunity of the operation.

chum channel.

Unlike the Krug air defense system, the radio command guidance system of the Osa complex uses two sets of wide and medium beam antennas to capture and insert two missiles into the beam of the target tracking station when launched with a minimum interval (3-5 s) . In addition to the guidance methods used in the Krug air defense system, the Osa complex, when firing at low-flying targets (at altitudes of 50-100 m), uses the “slide” method, which ensures that the missile system approaches the target from above, which reduces targeting errors -you are on target, excluding the radio fuse from being triggered by the ground. The 9MZZ missile defense system is made according to the “duck” design. The rocket is not roll stabilized, and therefore the on-board equipment is equipped with a command dispenser. To reduce the roll moment created by the effect on the wings of the air flow disturbed by the rudders, the wing

block is made



Layout of the 9MZZ *SAM "Osa":*

1 - radio fuse transmitter; 2 - steering gear; 3 - power supply; 4 - air pressure accumulator; 5— radio fuse receiver; 6 - radio control equipment; 7 - autopilot; 8 - warhead; 9 - solid propellant rocket engine; 10 - stabilizer hinge.

freely rotating on a bearing relative to the longitudinal axis of the rocket. The main components of the rocket - radio control equipment (command radio unit) and radio sighting (transponder), autopilot, radio fuse, on-board power supply, warhead with a safety actuator - were located in the nose part of the missile defense system. And in the tail section there is an engine, antennas for the command radio unit and on-board transponder, as well as

sulfur to accompany the missile using television
optical viewer.

The missile defense system did not require pre-launch preparation, excluding the installation of on-board radio equipment during the loading process of the launcher. The complex ensures the destruction of

targets with a speed of 300 m/s at altitudes of 200-5000 m, in the range range from 2.2-3.6 km to 8.5-9 km (with a decrease in maximum range to 4-6 km for targets at altitudes of 50-100 m). For supersonic targets flying at speeds up to 420 m/s, the far boundary of the affected area did not exceed 7.1 km at altitudes of 200-5000 m. The parameter ranges from 2 to 4 km.

Calculated from the results of modeling and combat launches of missiles, the probability of hitting an F-4C (Phan-tom) type target with one missile was 0.35-0.4 at an altitude of 50 m and increased to 0.42-0.85 at altitudes over 100 m. The radius of destruction of a warhead at low altitudes for the same target is 5 m.

The self-propelled chassis provides average speeds for the complex on dirt roads during the day - 36 km/h, at night - 25 km/h, on highways - up to 80 km/h. When afloat, the speed reaches 7-10 km/h. In 1975, the modernized Osa-AK complex was put into service, which, compared to

the Osa air defense system, has

extended affected area.

In the 9AZZBM2 combat vehicle, the structure of the counting and solving device has been changed, the precision characteristics of the control circuit have been improved to ensure missile guidance at high speed (up to 500 m/s instead of 420 m/s for the Osa) and maneuvering with an overload of up to 8g (instead of 5g) targets. The possibility of destruction on catch-up courses at speeds of up to 300 m/s is ensured.

The conditions for automatic target tracking in passive mechs have been improved by introducing an external coherence mode in target tracking stations. The noise immunity of the complex as a whole has been improved. Some of the blocks were made on a new element base, reducing their weight, dimensions, power consumption and increasing reliability.

The missile's radio fuse was modified by introducing a two-channel receiver into it with an autonomous altitude analysis circuit at the time of cocking, which ensured that the missile did not detonate from the ground at an altitude of up to 27 m. Due to its placement in a container, the missile was equipped with a wing with a deployment mechanism after start. In the transport position, the upper and lower consoles folded towards each other. Before the launch, the front and back covers of the container opened and rose, rotating relative to the mounting axes.

The period of warranty control has been increased from 1 year to 5 years, and the radiation resistance of the rocket has been increased.

The combat effectiveness of the Osa-AK complex, depending on the position of the missile defense meeting points with the target in the affected area, ranged from 0.5 to 0.85. However, the Osa-

AK air defense system could not effectively fight fire support helicopters, the main modern means of fighting tanks.

Combat vehicle 9AZZBMZ air defense missile system "Osa-AKM"

In 1980, a modernized version of the 9KZZMZ (“Osa-AKM”) complex was put into service. When firing at helicopters at

altitudes less than 25 m, this complex used a special method of targeting missiles

with semi-automatic target tracking based on angular co-

ordinates using a television-optical viewfinder.

Many improvements affected the 9AZZBMZ combat vehicle. The 9MZZMZ missile was distinguished by a modified radio fuse. The modified complex,

compared to the serial one, had the capabilities of hitting hovering (and flying at speeds of up to 80 m/s) helicopters at almost zero altitude at ranges of 2-6.5 km with a heading parameter of up to 6 km.

Helicopters of the Hugh-Cobra type on the ground were hit with a probability of 0.07-0.12, flying at an altitude of 10 m - 0.12-0.55, hovering at an altitude of 10 m - 0.12-0.38 .

The Osa complex and all its modifications were in service with motorized rifle divisions as part of an anti-aircraft missile regiment. Each Osa anti-aircraft missile regiment consisted, as a rule, of five anti-aircraft missile batteries and a regiment command post with a control battery. The anti-aircraft missile battery consisted of four Osa complexes (combat vehicles) and a battery command post equipped with a PU-12 control post. The regiment's control battery included a control point PU-12 (PU-12M) and a detection radar P-15 (P-19).

The functioning of the complex's combat assets was ensured by the use of 9T217 transport and loading vehicles, 9V210 maintenance vehicles, 9F372 group spare equipment and accessories vehicles, 9V914 adjustment machines, 9V242 automated control and testing stations, and a 9F16 ground equipment complex.

In the air defense system, with a relatively short range, it was possible to ensure a high energy ratio of the reflected

from the signal target to the interference, which made it possible even in conditions

intense interference to be used for detection and resistance

radar channels drive the target, and when they are suppressed, a television-optical sight is used. According to the noise level -

The security of the Osa air defense system was superior to all first-generation military anti-aircraft systems.

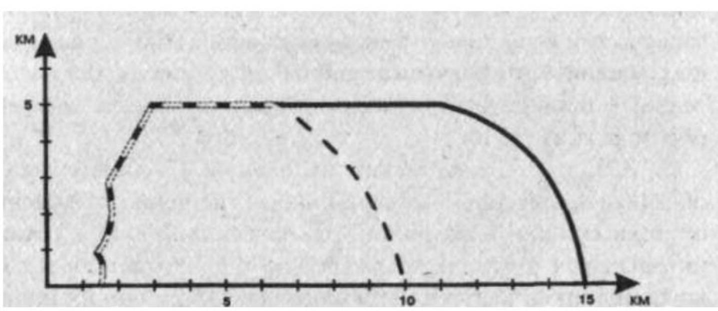
Therefore, when using the Osa air defense system in combat operations in Southern Lebanon in the early 80s, the enemy, along with electronic countermeasures, widely used a variety of tactics aimed at reducing the combat effectiveness of the complex, in particular the mass launch of simulating combat aircraft unmanned aerial vehicles with a subsequent attack by strike aircraft on positions that have expended the ammunition of the air defense system. In this way, three complexes belonging to Syria were destroyed, the fourth was subsequently shot down by an Israeli RF-4E Phantom aircraft.

Angola used the complex in December 1983 during a border conflict with the Republic of South Africa. The complex was also used by Libya on April 15, 1986 against American bombers, but, according to foreign press reports, not a single target was shot down.

During the hostilities of 1987-88. In Angola, Wasp units were used against the South African air force. They shot down two remotely piloted aircraft and a visual surveillance aircraft.

nia.

Before the start of Operation Desert Storm, a special a unit of the multinational force, using helicopters, entered Kuwaiti territory, captured and



Damage zone of the Osa-AK air defense system

carried the Osa air defense system with all the technical documentation, and captured a combat crew consisting of Iraqi military personnel. During the Gulf War in 1991, Iraqi Osa units were one of the most effective air defense elements (together with the ZSU-23-4 Shilka) against Tomahawk missiles. It is believed that several Tomahawk cruise missiles were shot down by the Osa air defense system.

Currently, production of the complex has been completed. The Osa is in service in 19 countries around the world.

Recently, on the basis of missiles of the Osa family of complexes, for use on routes up to 16 km long, the Saman target has been developed, simulating a target with an ESR from 0.08 to 1.6 m^2.

The air defense system was supplied to Angola (15 complexes), Algeria, Greece (12), India (48), Iraq, Jordan (50), Libya (50), Poland (60), Syria (60), Yugoslavia, South Africa.

TACTICAL AND TECHNICAL CHARACTERISTICS OF THE 9MZZ ROCKET

Damage range, km:	
maximum	yu.0
minimum	1.5
Damage height, km:	
maximum	5.0
minimum	0.03
Rocket length, m	3.2
Rocket diameter, m	0.21
Wingspan, m Weight, kg:	0.65
missile	126.3
warhead Warhead	20.0
type	High-explosive fragmentation with contact and non-contact fuses
Maximum rocket speed, M Reloading	2.4
time, min Engine	5 solid fuel

"Tunguska" (RUSSIA)

The development of the Tunguska complex (SA-19 Grisson) initially envisaged the creation of a new cannon anti-aircraft self-propelled gun (ZSU) to replace the well-known Shilka self-propelled gun (ZSU-23-4).

Despite the successful use of the Shilka in the wars in the Middle East, during these hostilities its shortcomings were also revealed - short reach of targets (no more than 2 km in range), low power of projectiles, as well as the impossibility of timely detection of air targets and

their pass.

However, the feasibility of developing an anti-aircraft gun-missile system raised serious doubts due to the adoption of the Osa-AK air defense system in 1975, which had a similar-sized aircraft engagement zone in range (up to 10 km) and larger, than that of the Tunguska self-propelled gun, the size of the aircraft's destruction zone in height (0.02-5 km).

But this did not take into account the specifics of the armament of the regimental air defense unit for which the ZSU was intended, as well as the fact that when fighting helicopters, the Osa-AK air defense system was significantly inferior to the Tunguska ZSU, since it had a significantly longer working time - more than 30 s versus 8-10 s for the Tunguska self-propelled gun. The short reaction time of the Tunguska self-propelled gun ensured a successful fight against briefly appearing (“jumping”) or suddenly flying out due to

folds of the terrain by helicopters and other low-flying targets, which the Osa-AK air defense system could not provide.

In the Vietnam War, the Americans first used ver-
helicopters armed with anti-tank guided missiles
ketami (ATGM). It became known that 89 out of 91 approaches of helicopters with ATGMs in an attack on armored targets were successful.
non-technical vehicles, artillery firing positions and other ground
goals.

The only anti-aircraft weapon capable of effectively combating hovering helicopters could be the Tunguska ZSU, which has the ability to accompany tanks as part of their battle formations and has a sufficiently long range of the affected area (4-8 km) and short operating time (8- 10 s). Joint (state) tests of the Tung-Guska complex were carried out from September 1980 to December 1981 at the Donguz test site. The complex was put into service in 1982.

Combat vehicle 2S6 anti-aircraft gun and missile system
Lexa consisted of the following fixed assets placed on a high-cross-country tracked self-propelled vehicle:

- cannon armament, which included two 30-mm 2A38 machine guns with a cooling system and ammunition ammunition
  ron to them;
- missile weapons, which included eight launchers with guides and ammunition for 9M311 missiles in transport and launch containers, an encoder, equipment

  coordinate selection tour;
- power hydraulic drives for gun guidance and launching missile launchers;
- radar system, consisting of target detection RAS, target tracking RAS and ground radio

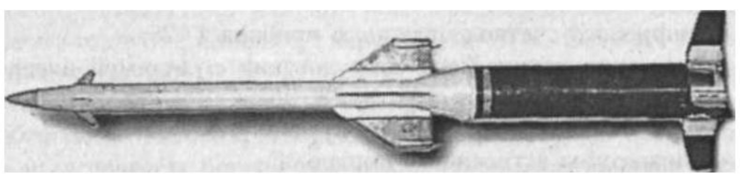
  requestor;
- digital counting and solving device 1A26; • sighting and optical equipment with a guidance system
  tion and stabilization;
- pitch and course measurement systems;
- built-in control equipment;
- navigation equipment;

• life support systems;
• communication
systems; • automation and auto-blocking systems;
• anti-nuclear, anti-chemical and anti-
biological protection. The

2A38 double-barreled anti-aircraft machine gun of 30 mm caliber fired cartridges fed from a cartridge belt common to the two barrels using a single feed mechanism. The machine gun had one firing mechanism that served the left and right barrels alternately. The shooting was controlled remotely, using an electric trigger. Cooling of the barrels is liquid: water or using antifreeze (at negative air temperatures). The machine operated at elevation angles from -9° to +85°. The survivability of the machine gun (without changing barrels) was at least 8,000 shots (with a firing mode of 100 shots per machine gun with subsequent cooling of the barrels). The initial speed of the projectiles is 960-980 m/s.

The 9M311 anti-aircraft guided missile weighing 42 kg (transport-launch container with the missile - 57 kg) was built according to a bi-caliber design with a detachable engine. It had a single-mode propulsion system, consisting of a lightweight starting engine with a plastic housing with a diameter of 152 mm. This engine gave the rocket an initial speed of 900 m/s and separated upon completion of work approximately 2.6 seconds after launch.

Double-barreled anti-aircraft machine gun 2A38 caliber 30 mm



Anti-aircraft guided missile 9M311

After the missile launcher was brought to the target's line of sight, its sustainer stage (mass - 18.5 kg, diameter - 76 mm) continued its flight by inertia. The average speed of the missile was 600 m/s, and the average available overload was 18g, which made it possible to ensure the destruction of targets flying at speeds of up to 500 m/s and maneuvering with an overload of 5-7g on oncoming and overtaking courses. The absence of a propulsion engine eliminated smoke from the optical sight line of the target. This ensured reliable and accurate guidance of missiles, reduced the weight and dimensions of the missile, and simplified the layout of on-board equipment and combat equipment. The missile's combat equipment consisted of a warhead, a non-contact

target sensor and a contact fuse. Occupying almost the entire length of the sustainer stage, the warhead weighing 9 kg was made in the form of a large elongation compartment with rod striking elements, surrounded by a fragmentation jacket to increase efficiency. The warhead provided cutting action on elements

airframe design targets and incendiary - by element
its fuel system. With small misses (up to 1.5 m), a high-explosive effect was also provided. The warhead was detonated at a distance of up to 5 m from the target using a signal from a non-contact sensor, and in the event of a direct hit (the probability of which reached approximately 60%) - with a contact fuse. The non-contact sensor weighing 0.8 kg consisted of 4

semiconductor lasers forming an eight-beam radiation pattern perpendicular to the longitudinal axis of the rocket. The laser signal reflected from the target was received by photodetectors. The range of reliable operation was 5 m, the range of reliable non-activation was 15 m. The non-contact sensor was armed by radio commands 1 km before the missile defense missile met the target, and when firing a missile at ground targets it was turned off

before the start.

The onboard equipment of the missile defense system included an antenna-wave-water system, an electronic unit, a gyroscopic coordinator, a steering drive unit, a tracer, and a power supply.

The missile used passive aerodynamic damping of the missile defense airframe in flight, which was ensured by correction of the control loop when transmitting commands to

a missile from the combat vehicle's computer system. This is made it possible to obtain sufficient guidance accuracy, reduce the weight and dimensions of on-board equipment and missile defense systems in general. The length of the rocket was 2.56 m, the diameter was 0.15 m. The target detection station (STS) of the Tunguska complex combat vehicle was a coherent-pulse radar with all-round visibility in the decimeter wave range. The high stability of the frequency of the transmitter, made in the form of a master oscillator and an amplifier circuit, and the use of a filter circuit for selecting moving targets ensured a high coefficient of suppression of reflections from local objects (30-40 dB), which made it possible to detect targets against the background of intense reflections from under - covering surface and in passive interference.

The target tracking station (TSS) was a centimeter-wave coherent-pulse radar with a two-channel tracking system based on angular coordinates and with filter circuits for selecting moving targets

Combat vehicle 2S6 ZPRK "Tunguska" in combat position

in the channels of the auto-rangefinder and angular auto-tracking. The suppression coefficient for passive interference and reflections from local objects was 20-25 dB. The station switched to automatic tracking in target designation and sector target search modes. The search sector was 120° in azimuth and 0-15° in elevation. Both stations successfully detected and tracked low-flying and

hovering helicopters. The detection range of a helicopter flying at a speed of 50 m/s at an altitude of 15 m with a probability of 0.5 was 16-17 km, the range of transition to auto tracking was 11-16 km. A hovering helicopter was detected by the detection station based on the Doppler frequency shift from the rotating propeller and was taken for automatic tracking in three coordinates by the target tracking station.

The stations had circuit protection against active interference, as well as the ability to track a target in interference due to combinations in the use of radar and optical means of the combat vehicle. Due to these combinations, separation of operating frequencies of stations, time-regulated or simultaneous operation at close frequencies of several (distant from each other at a distance of more than 200 m) combat vehicles in the battery could be provided

reliable protection against anti-radar missiles of the Shrike or Standard ARM type. The operation of the 2S6

combat vehicle was carried out mainly autonomously, but work in the control system of air defense systems of the ground forces was not excluded.

After searching, detecting and identifying the target, the tracking station switched to its automatic tracking along all coordinates.

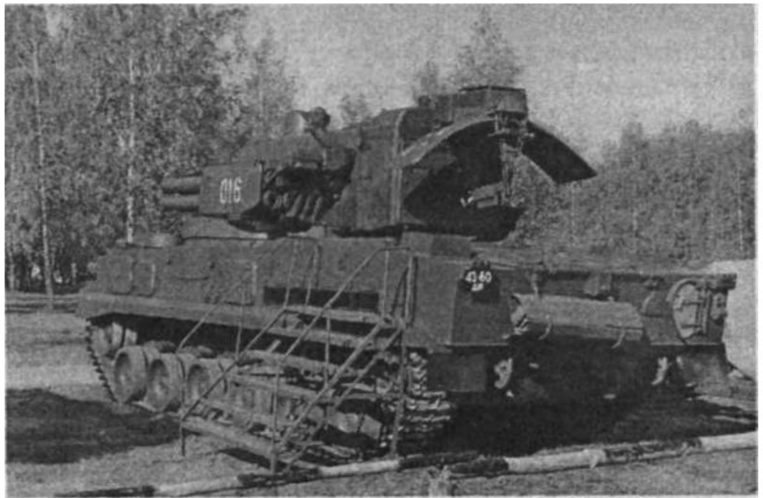
When firing anti-aircraft guns, a digital computing system solved the problem of a projectile meeting a target and determined the affected area based on data coming from the output shafts of the tracking station antenna, from the unit for isolating error signals by angular coordinates and from the range finder, as well as from the system for measuring pitching angles and heading of the combat vehicle. In the event of an enemy intense interference from the tracking station via the measurement channel

rangefinder (autorangefinder), a transition was made to manual tracking of the target in range, and if impossible - even manual tracking - to track the target by distance from the detection station or its inertial tracking. When causing intense interference to a station tracking along angular channels target tracking along azimuth and elevation were carried out with an optical sight, and in the absence of visibility - inertially (from a digital computer system).

Target tracking was used when firing missiles by angular coordinates using an optical sight. After launch, the missile system fell into the field of view of the optical direction finder of the missile coordinates selection equipment. Based on the light signal from the missile tracer, the equipment generated the angular coordinates of the missile defense system relative to the target's line of sight, which were fed into the computer system. It generated SAM control commands that entered the encoder, where they were encoded into pulses and

through the transmitter of the tracking station were transmitted to rocket.

If there is no information in the computer system about the range to the target from tracking stations or detection

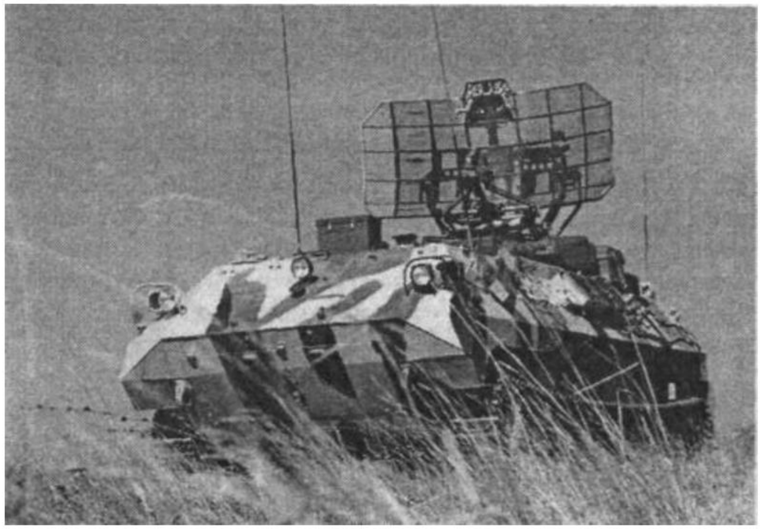


Боевая машина «Тунгуска» в транспортном положении

In addition, an additional missile guidance mode was used, in which the missile was immediately launched onto the line of sight of the target, the non-contact sensor was cocked 3.2 s after the launch of the missile defense system, and the combat vehicle was brought into readiness to launch the next missile after the time had elapsed

rocket flight to maximum range.

Organizationally, the four combat vehicles of the Tunguska complex were combined into an anti-aircraft missile and artillery platoon of an anti-aircraft missile and artillery battery, consisting of a platoon of the Strela-USV air defense system and a platoon of the Tunguska complexes. Bata-Rhea was part of the anti-aircraft division of a motorized rifle (tank) regiment. The PU-12M control post was used as a battery command post, which was connected to the command post of the anti-aircraft division commander - the regiment's air defense chief. The latter was used as a control point for air defense units of the regiment "Ovod-M-SV" (mobile reconnaissance and control point PPRU-1) or its modernized version - "Assembly" (PPRU-1M). In the future, the combat vehicles of the Tun-Guska complex were to be interfaced with the unified battery command post 9S737 ("Rangier"). At



Control point for air defense unit of motorized rifle regiment 9C80-J

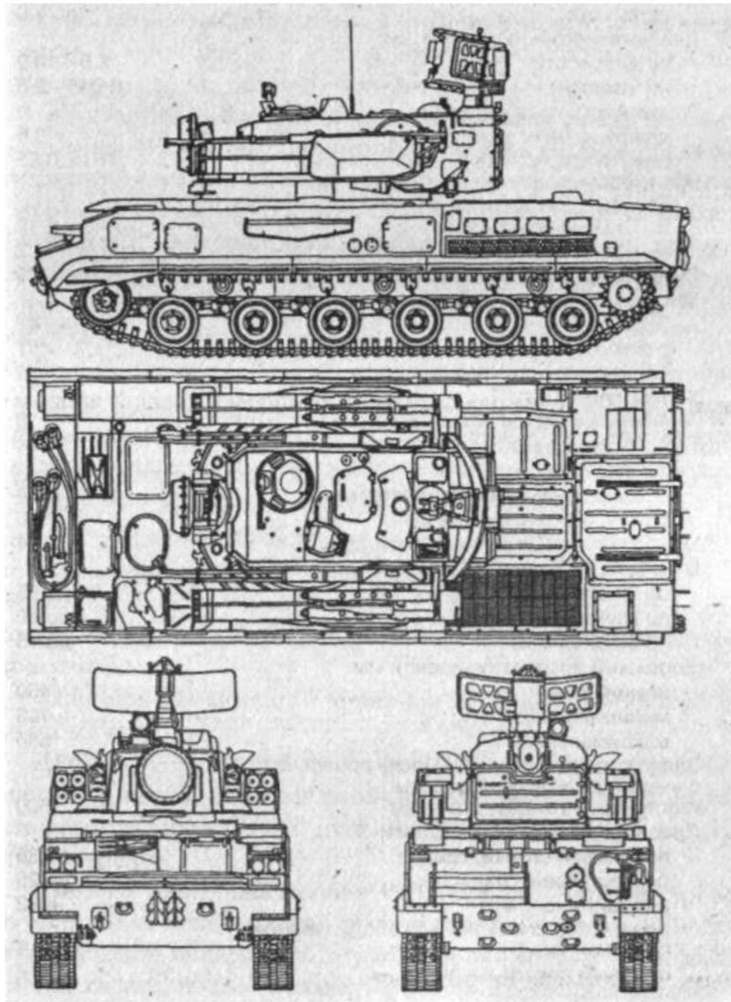
When pairing the Tunguska complex with the PU-12M, control commands and control commands from the latter to the combat vehicles of the complex were to be transmitted by voice using standard radio stations, and when paired with the 9S737 command post, using codegrams generated by data transmission equipment , with which these facilities should have been equipped. In the case of control of the Tunguska complexes from the battery command post, the analysis of the air situation and the selection of targets for firing by each complex had to be carried out at this point. In this case, orders and target designations were to be transmitted to combat vehicles, and data on the state and results of combat work were to be transmitted from the complexes to the battery command post. It was intended in the future to provide direct interface between the anti-aircraft gun and missile system and the command post of the air defense chief of the regiment using a telecode data transmission line.

The functioning of combat vehicles of the Tunguska complex is ensured baked using transport-loading vehicles 2F77M (KamA343101, 2 rounds of ammunition and 8 missiles), repair and maintenance vehicles 2F55-1 (Ural-43203 with trailer) and 1R10-1M (Ural-43203, for radio-electronic equipment), maintenance vehicles 2V 110-1 (“Ural-43203”, for artillery units), automated control and testing mobile stations 9V921 (on GAZ-66), maintenance workshops MTO-ATT-M1 (ZIL-131).

By mid-1990, the Tunguska complex was modernized and received the name Tunguska-M (2K22M). The main improvements to the complex were the introduction of new radio stations and a receiver for communication with the Ranzhir battery command post (PU-12M) and the PPRU-1 M command post (PPRU-1), as well as the replacement of the gas turbine engine of the complex's power supply unit with new - with an increased service life (600 instead of 300 hours). In the same year it was put into service. In the subsequent modification of the Tunguska-M 1, the processes of targeting missiles and exchanging information with the battery command post were automated. In the 9M311-M missile, the laser non-contact target sensor was replaced by a radar one, which increased the likelihood of hitting ALCM-type missiles.

Instead of a tracer, a pulse lamp was installed, as a result of which the efficiency increased by 1.3-1.5 times, and the destruction range reached 10 km.

Due to the collapse of the USSR, work is underway to replace the GM-352 chassis produced in Belarus with the GM-5975 developed by the Mytishchi Metrovagonmash Production Association.

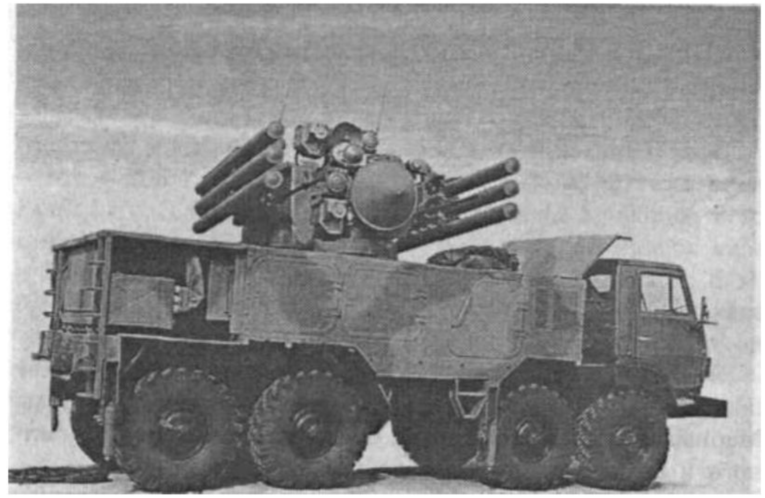


TACTICAL AND TECHNICAL CHARACTERISTICS ZSU 2S6M1

Range, km: detection	
of SOC support SSC	18
Speed, m/s:	16
missile flight, average target hit	600
Speed of viewing space	to 500
SOC, deg./s Borders of the affected area for cannon weapons, km:	360
by range	up to 4.0
in height	up to 3.0
For missile weapons, km:	
by range	2.5—10.0
in height	0.015—3.5
Chance of defeat:	
for cannon weapons for missile weapons	0.6
	0.65
Operating time from the moment the first mark appears from the target until the moment it is fired, s Number of anti-aircraft guns,	no more than
pcs. Total rate of fire, rounds/min. Weight, kg:	
	10 2 to 5000
missiles	42
missiles in TPK	57
missile warhead Ammunition,	9
pcs.: anti-aircraft guided	
missiles 30 mm cartridges	
	8 1904
of them:	
high-explosive fragmentation-incendiary	1524
fragmentation-tracer Weight of a fully	380
loaded SPAAG, t Speed of the SPAAG, km/h:	34
along the highway	up to 65
on a dirt road off-road	up to 40
	up to 15
Ground clearance (clearance), mm: nominal	
minimum maximum	450
	180
	580
Cruising range for fuel and oil on the highway, taking into account two-hour operation of the gas turbine engine, km Obstacles to be overcome:	500
ascents and descents, degrees.	up to 35
lateral roll, deg. ditches width,	up to 25
m fords (without special	up to 2
equipment) depth, m snow cover depth, m	
	up to
	1 up to 0.6

"Pantsir-S1"

(RUSSIA)



The Pantsir-S1 short-range anti-aircraft gun and missile system is designed for air defense of strategically important objects, capable of combating wide class of air attack weapons, including tactical aircraft, helicopters, ballistic and cruise missiles, guided bombs, striking elements of precision weapons. The complex is also capable of destroying lightly armored ground targets and enemy personnel.

"Pantsir-S1" was created on the principle of the Tunguska anti-aircraft gun complex.

To carry out its tasks, the Pantsir-S1 air defense missile system is equipped with 12 57E6 anti-aircraft guided missiles and two 2A72 automatic 30-mm cannons with 750 rounds of ammunition.

There is a multi-band RAS "Helmet" in the millimeter range, which allows you to detect air targets with an effective dispersion surface of up to 2-3 m^2 to the distance areas over 30 km and capture them for escort with

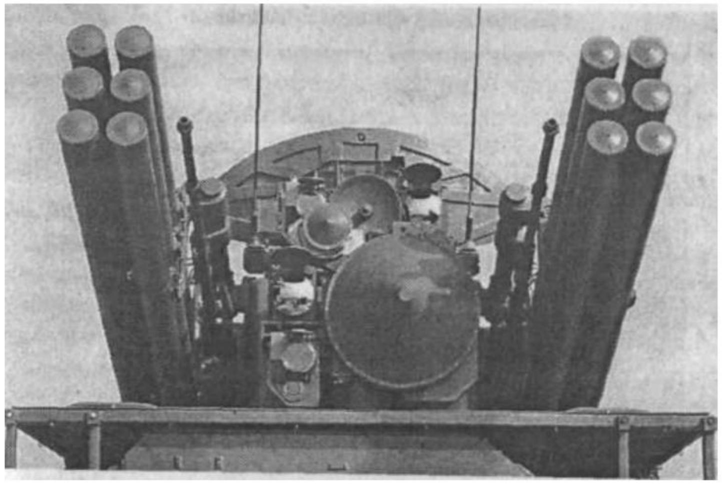
range 24 km or more. A passive mode of operation of the radar is possible due to the use of a long infrared channel new wave range with subsequent automatic matching pursuing the goal.

The Pantsir-S1 air defense missile system is capable of firing at two simultaneously tracked targets. Fire performance allows you to fire up to 12 targets in one minute.

The affected area of the complex when using a missile channel is from 1 to 20 km in range, and from 5 to 8000 m in height. When using an artillery channel, the affected area is from 200 to 4000 m in range and from 5 to 3000 m in height. The probability of hitting a target, depending on their type and firing conditions, ranges from 0.6 to 0.8, and the reaction time of the complex is 5-6 s. The 57E6 missile defense system is made according to a two-stage design, has a bi-caliber body and a

detachable starting motor. The sustainer stage consists of combat equipment, contact and non-contact fuses and on-board equipment. The rocket is in a container. Anti-aircraft guns, similar to the Tunguska-M1 air defense missile system, have a rate of fire of 700 rounds/min, and the initial projectile speed is 960 m/s. .

Tracked version of the Pantsir-C1 anti-aircraft missile system chassis



turret installation of the Pantsir-C1 complex with weapons, detection and tracking systems

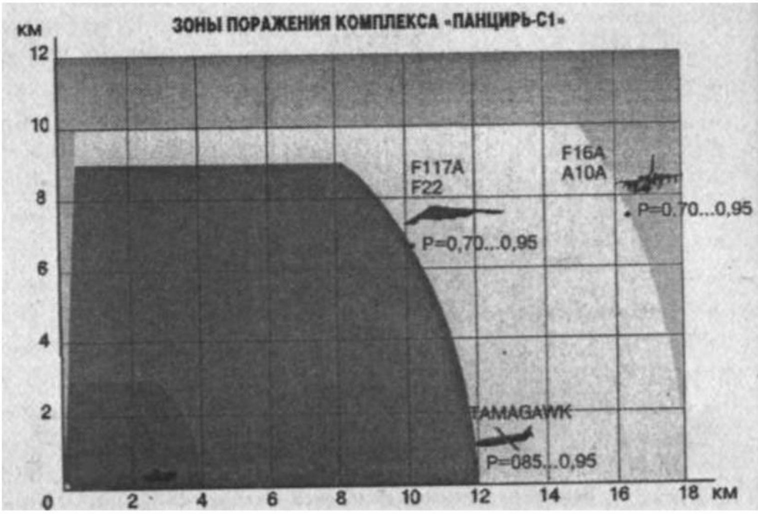
Tracked and wheeled versions of the chassis are possible.

Lead creator and manufacturer of the Pantsir-S1 anti-aircraft missile system - Tula Instrument Design Bureau.

A contract was concluded with the United Arab Emirates for the supply of three batches with a total number of 50 Pantsir-S1 air defense missile systems over three years.

The contract with the UAE provides for the supply of air defense systems on a tracked chassis, although the wheeled version based on the Ural-5323 (four-wheeled) is more mobile and cheaper to operate. The combat crew is three people. It is possible to install the

Pantsir-S1 air defense missile system on a warship.



TACTICAL AND TECHNICAL CHARACTERISTICS

Missile range, km:	
maximum	12.0
minimum	1.0
Cannon engagement range, km:	
maximum	4.0
minimum	0.02
Height of missile strike, km:	
maximum	6.0
minimum	0.005
Cannon strike height, km:	
maximum	3.0
minimum	ground level 3.2
Rocket length, m	
Rocket diameter, m	0.17
Rocket mass, kg	90.0
Warhead mass, kg Maximum	16.0
missile speed, m/s Reaction time, s Time for	1100
bringing into firing	5—
position, min Time for bringing into stowed position, min	
Crew, persons	8 3 5
	3

"Thor"

(RUSSIA)

By the mid-80s, the tasks facing military anti-aircraft air defense missile systems had changed significantly, and at the same time, new technological possibilities for solving them had emerged. A vital necessity has become the fight against new weapons that have appeared on

enemy weapons, namely, Walleye-type gliding bombs, cruise missiles of the ASALM, ALCM type, remotely piloted aircraft of the BGM-34 type.

Carrying out new tasks required automating the process of conducting combat work; combat crews could not manually solve the above tasks in full on their own.

Work on the creation of the Top (9K330) air defense system began in early 1975 and continued until 1983 (head developer NIEMI of the Ministry of Radio Industry). As with the creation of the Osa air defense system, in parallel with the development of air defense systems for

The ground forces also began work on the Kinzhal ship complex, which was partially unified with it. The complex was adopted for service in 1986. Partially unified with the Tor air defense system, the Kinzhal complex entered service with Navy ships later

three years.

The complex ensures the destruction of a target flying at a speed of 300 m/s at altitudes of 0.01–6 km, in the range of 1.5–12 km with a parameter of up to 6 km. At a target speed of 700 m/s, the maximum destruction range is reduced to 5 km, the range of destruction heights is narrowed from 0.05 to 4 km, and the parameter does not exceed 4 km.

The effectiveness of one missile defense against aircraft is 0.30-0.77, for helicopters - 0.50-0.88, for drones - 0.85-0.95. The reaction time of the complex is 8-12 s, transferring to combat-ready and traveling positions is 3 minutes, loading a combat vehicle using TZM is no more than 18 minutes.

The main type of combat work of the Tor air defense system is the autonomous operation of batteries, but centralized and mixed control of these batteries by the head of the division's air defense and the commander of the anti-aircraft missile regiment is not excluded.

The successful scheme of vertical missile launch, used in the S-300 system, made it possible to implement it in the Tor air defense system: 8 missiles are placed vertically along the axis of the combat vehicle's turret, which protects them from climatic influences and from damage from bomb fragments and shells.

The main combat weapon of the complex is the 9A330 combat vehicle, which includes: • target detection station (TDS) with systems for identifying their nationality and stabilization

antenna bases;

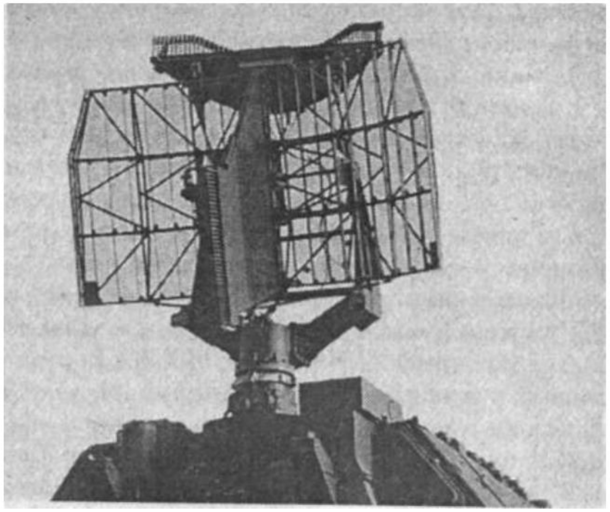
• a guidance station (SN) with one target channel, two missile channels and a channel for the SAM acquisition coordinator; • special computer; • a launching device that provides vertical sequential launch of eight missiles located on the combat vehicle;

tire;

• equipment of various systems (starting automation, navigation and topographical reference systems, documentation of

process of combat work, systems for functional control of a combat vehicle, autonomous power supply [based on a gas turbine electric generator] and life support). All of these technical means are located on a self-propelled, high-cross-country tracked chassis developed by the Minsk Tractor Plant GM-355, unified with the chassis of the Tung-Guska anti-aircraft gun and missile system. The mass of the combat vehicle with eight missiles and a combat crew of 4 people was 32 tons.

The target detection station is a coherent-pulse radar with all-round visibility in the centimeter wave range with frequency control of the beam in elevation. The beam, 4° wide in elevation and 1.5° in azimuth, could occupy eight positions in the elevation plane, covering a sector of 32°. Simultaneous elevation angle viewing in three beams can be performed. The order of review along the rays was established using computer software. The main operating mode provides for a 3-second review rate of the detection zone, with the lower part of the zone being scanned twice. If necessary, you can provide an overview of the space in three selected beams at a rate of 1 s. Marks from the coordinates



Antenna of the Tor air defense missile system detection station

There, up to 24 detected targets were tied into tracks (up to ten tracks). Targets are displayed as dots on the commander's indicator with vectors characterizing the magnitude and direction of the speed of its movement, forms containing the route number, the target number according to the degree of danger (according to the minimum time of entry into the affected area), and the number of the beam in which the target is located are displayed. When operating in strong passive interference, the target detection station is provided with blanking of this area of space. If necessary, you can enter the target coordinates from the blanking sector into the computer to develop target designation by manually placing a marker on a target covered by interference and manually taking its coordinates.

The resolution of the target detection station is no worse than 1.5°-2° in azimuth, 4° in elevation and 200 m in range. The maximum errors in determining the target coordinates are no more than half of the specified resolution values. The target detection station provides detection of F-15 type aircraft flying at altitudes from 30 to 6000 m, at ranges of 25-27 km with a probability of at least 0.8 (unmanned air attack vehicles - at ranges of 9-15 km with a probability of not less than 0.7). Helicopters on the ground with rotating propellers were detected at a distance of 6-7 km with a probability of 0.4-0.7, hovering in the air - at a distance of 13-20 km with a probability of 0.6-0.8, and those jumping from the ground to a height of 20 m - 12 km with a probability of at least 0.6. Protection against anti-radar missiles used by an air enemy is ensured by their timely detection and destruction by own missiles.

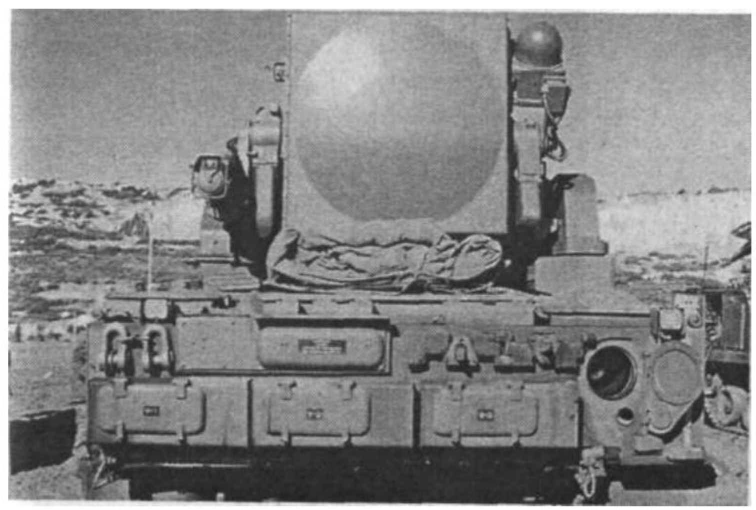
The guidance station is a coherent-pulse radar of the centimeter wave range with a small-element phased antenna array (PAR), which forms an electron beam 1° wide in azimuth and elevation and provides electronic scanning of the beam in the corresponding planes. The station provides target search in a sector of 3° in azimuth and 7° in elevation, automatic tracking of one target in three coordinates using the monopulse method,

launch of one or two missiles (with an interval of 4 s) and their guidance on target.

The transmission of guidance commands on board the missile is carried out by a single station transmitter through the phased array. The same antenna provides, through electronic scanning of the beam, simultaneous measurement of the coordinates of a target and two missiles aimed at it.

The resolution of the guidance station is no worse than 1° in azimuth and elevation, 100 m in range. The root mean square error of a fighter's auto tracking is no more than 7 m in range and 30 m/s in speed. The root-mean-square error of SAM tracking in range is no more than 2.5 m. The guidance station provides a range for switching to auto-tracking of a fighter equal to 23 km with a probability of 0.5 and 20 km with a probability of 0.8.

The missiles are located in the launcher of a combat vehicle without transport containers and are launched vertically using powder catapults. The launching and antenna devices of the combat vehicle are structurally combined into an antenna-launching device that rotates about the vertical axis.



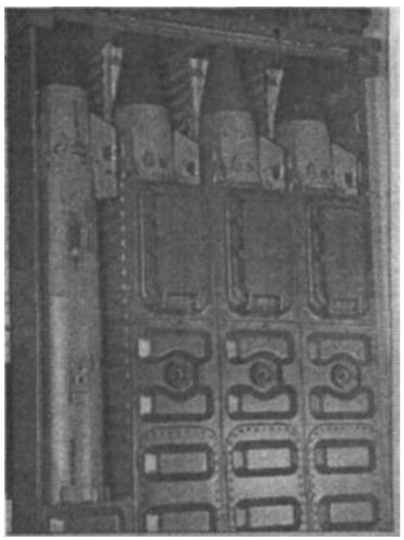
Phased array of the Tor air defense missile system guidance station

The 9M330 solid-propellant missile defense system is made according to the “duck” design and is equipped with a device that provides gas-dynamic declination. The rocket uses folding wings that open and lock into flight position after launch. In the transport position, the left and right consoles fold towards each other. The rocket is equipped

active radio fuse, autopilot with ru-
lei, radio unit, high-explosive fragmentation warhead with a safety-actuating mechanism, power supply system, gas supply system for steering actuators during the march and gas-dynamic rudders at the launch site. On the outer surface of the rocket body there are antennas for the radio blaster and the radio unit, and a powder ejection device is also installed. Loading missiles into combat

the machine is carried out using a transport-charging machine.

At launch, the rocket is ejected vertically by a catapult at a speed of about 25 m/s. Declination of the rocket at a given level
angle, the magnitude and direction of which is entered before starting
volume into the autopilot from the guidance station, carried out until
launch of a rocket engine as a result of the outflow of products



Anti-aircraft missiles and their placement in the 9M334 missile module

combustion of a special gas generator installed at the operating
new aerodynamic steering. Gas ducts leading to pro-
oppositely directed nozzles, overlap depending on the angle of rotation of the steering wheel. Gas dynamic device
tilts the rocket in the desired direction, and then before turning on
stopping the solid fuel engine stops it
gate

The rocket engine is launched at an altitude of 16-21 m. After launch, the rocket picks up speed, which at a distance of 1.5 km is 700-800 m/s. The command guidance process begins at a range of 250 m. Due to the wide range of linear dimensions (from 3-4 to 20-30 m) and target movement parameters (from 10 to 6000 m in height and from 0 to 700 m/ s in speed) for optimal destruction of high-flying targets with fragments of the warhead, from the guidance station on board the missile defense system, the delay values of the radio fuse are given, depending on the speed of approach of the missile to the target. At low altitudes, selection of the underlying surface and activation of the radio fuse is ensured

only from the target.

Simultaneously with the adoption of the Tor air defense system work began on its modernization.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum	12.0
minimum	0.5
Damage height, km:	
maximum	6.0
minimum	0.01
Probability of target hit type aircraft with one missile	0.26—0.75
Number of target channels	
9M330 missile length, m	1
9M330 missile body diameter, m	2.89
Wingspan, m Weight,	0.23 o.65
kg: missile	
	165.0
warhead, kg	14.8
Reloading time, min	18

"Tor-M1" (RUSSIA)

The Tor-M1 complex is designed to solve air defense problems at the divisional level. It provides effective air defense of military and civilian targets from sudden attacks by cruise missiles, guided bombs, airplanes, helicopters, unmanned and remotely controlled aircraft.

devices.

The complex is capable of performing combat missions in any climatic conditions. The distinctive features of the Tor-M1 air defense system from other systems of this class are high maneuverability, mobility, short reaction time, automation of combat work, and efficiency when firing at a wide class of targets.

The complex was created on the basis of the Tor air defense system. As a result of modernization, a second target channel was introduced into the complex; the missile used a warhead with increased lethality. characteristics, a modular coupling of the missile defense system with the combat vehicle has been implemented, the engagement zone of low-flying targets has been increased, the combat vehicle has been interfaced with

a unified battery command post "Ran-zhir" to ensure control of combat vehicles in the battery. State tests of the Tor-M1 air defense system were carried out from

March to December 1989, it was put into service in 1991. The probability of hitting typical targets with one missile defense system was increased compared to the Tor air defense system when firing at ALCM-type cruise missiles from 0.45-0.95 to 0.56-0.99, for BGM type RPV - from 0.86-0.95 to 0.93-0.97, for F-15 type aircraft - from 0.26 -0.75 to 0.45-0.80 and for Hugh Cobra helicopters - from 0.50-0.98 to 0.62-0.75. The affected area of the Tor-M1 air defense system when firing simultaneously at two targets remained

almost the same as that of the Tor complex at one target, which is ensured by reducing the reaction time of the Tor-M1 complex from 8.7 to 7 .4 s when shooting from a position and from 10.7 to 9.7 s - when shooting from a short stop after movement.

The Tor-M1 anti-aircraft missile system includes: a combat vehicle (9A331), a transport-loading vehicle (9T244), maintenance and repair equipment.

Some changes were made to the 9A331 combat vehicle - nia (compared to 9A330):

- a new dual-processor computing system with increased performance was used, which implemented dual-channel work on targets, protection against false target traces, and expanded functional control; • a three-channel digital signal processing system has been introduced into the target detection station, providing more effective suppression of passive interference without additional analysis of the interference environment; the amplifier in the receiver input devices has been replaced to increase sensitivity; the viewing order has been changed space to reduce the time of tying target routes, an algorithm for protecting against false marks has been introduced; • a new type of probing signal has been introduced in the guidance station, providing detection and automatic tracking of a hovering helicopter, an automatic target tracking in elevation angle has been introduced in the television-optical sight (to increase the accuracy of its tracking), an improved

commander's indicator and interface equipment with the unified battery command post "Ranzhir" (radio stations and data transmission equipment). For the first time in the practice of creating an air defense system, instead of a launcher, a four-seat transport and launch container 9YA281 for the 9M331 missile with a body made of aluminum alloys was used, which, together with these missiles, formed the 9M334 missile module. The mass of the module with four missiles, with catapults and TPK is 936 kg. The TPK body is divided by diaphragms into

four cavities,

For transportation and storage, rocket modules were assembled using beams into packages - up to six modules in a package. The 9T244 transport vehicle was capable of transporting two packages of four modules, and the transport-loading vehicle was capable of transporting two packages of two modules.

The combat vehicle is mounted on the GM-355 tracked chassis, which has variable ground clearance. Hydromechanical transmission and hydropneumatic suspension provide good maneuverability and smooth ride on rough terrain

terrain.

The combat vehicle houses information and command equipment, control, navigation and communication devices, two transport and launch containers with four missiles in

each, an autonomous power supply system.

Транспортная машина 9Т244

Information and command means provide target detection, measurement of their coordinates and missile guidance. They include radar stations for detecting, tracking targets and missile guidance, systems for identifying targets and secondary processing of radar information, a radar for locking and launching a missile onto a target trajectory, a high-speed digital specialized computer “Saver”, and also remote control

controls with indication means.

The target detection radar is a three-coordinate Doppler all-round locator with multi-channel digital signal processing. Operating in conjunction with a computer, it detects and identifies up to 48 targets at a range of 25 km, and then tracks the ten most dangerous of them. These

According to the danger criterion, targets are distributed into a priority row. Shooting is being prepared for the most “important” of them. Data about these targets is sent to the commander's console and, in parallel, to the target tracking and missile guidance station.

The target tracking and missile guidance station - a mono-pulse Doppler radar with phased array and electronic beam control - clarifies target designation parameters, implements

Provides tracking and four-coordinate measurement of target motion parameters. The maximum viewing range is 25 km. In the working sector, the coordinates of two targets are simultaneously measured and missiles are aimed at them. Based on trajectory and signal characteristics, targets are ranked by class; this information enters the missile control system to optimize its flight mode. A digital specialized computer processes data and controls all systems -

mi complex.

During the movement of a combat vehicle, including in combat formations of covered troops, target detection and analysis of the air situation is carried out due to gyro-stabilization of the search locator antenna system. Stopping is required only for missile firing. In the stowed position, the radar antennas are folded.

In a complex jamming environment (with dense enemy radio-electronic countermeasures) and at extremely low target flight altitudes, a backup (television) tracking channel can be used. Inside the circular rotation tower there is a launcher shaft. Two TPKs are placed vertically in it

with rockets.

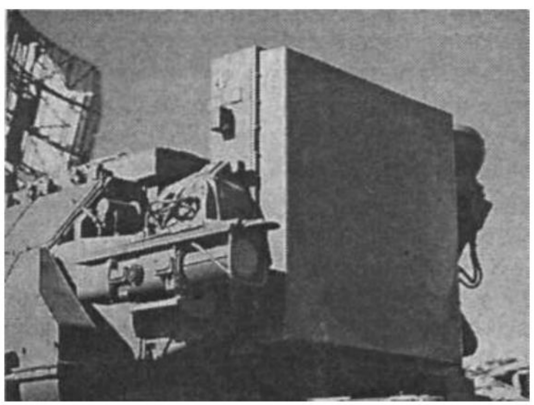
The 9M331 missile defense system is solid fuel, single-stage, made according to the canard aerodynamic design with a radio command guidance method. High-explosive fragmentation warhead including

expects fragments of a high-density alloy.

The warhead is detonated by an active radio fuse. The missile has high maneuverability (permissible overloads are up to 30 g), which allows it to hit high-speed, low-altitude, small-sized and armored targets maneuvering with overloads up to 12 g. The 9M331 missile defense system is delivered to the troops in a fully equipped state and does not require maintenance for 10 years.

The rocket is launched vertically from the silo using a tapult, and after exiting the shaft, with the help of gas-dynamic rudders located in the bow, it turns in the direction of the target. Then the propulsion system is turned on. Autonomous wide-angle direction finder of the air defense missile system

engages the missile and then launches it into the radar beam guidance



Guidance station and television optical sight

The missiles' ammunition is replenished using a transport-loading machine equipped with a special manipulator. Loading a full load of missile ammunition requires 18 minutes; loading missiles is also possible from a conventional transport vehicle

using a crane.

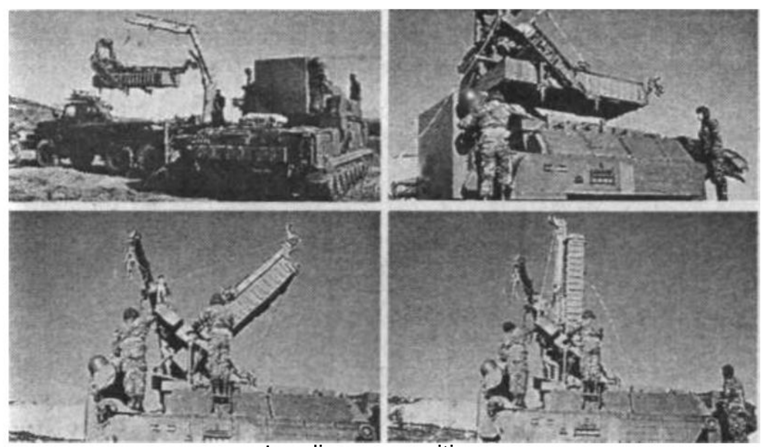
The navigation, topographical and orientation system of the complex automatically determines the coordinates of the combat vehicle and plots the course of its movement, and also makes mutual reference with other military assets with the accuracy necessary for the exchange of information about the air situation.

The combat vehicle's equipment is powered from a built-in power plant, which has a main drive from a gas turbine unit and an auxiliary drive from the power take-off system of the chassis diesel engine.

To maintain combat readiness and reliable assessment status of the complex equipment there is an automatic built-in functional control system. In case of failure it searches for a faulty element with an accuracy of up to a group of panels. The equipment of the complex is made

taking into account the latest technical achievements and technologies, has developed functional control, which ensures high performance

new reliability.



Loading ammunition

The crew of the combat vehicle is 3 people: commander, operator and driver. The crew is protected from weapons of mass destruction, the life support system creates normal living conditions inside the working compartment of the tower. There is a special autonomous simulator for training combat vehicle operators.

A significant difference between the “Tor-M1” air defense system and the “Tor” complex was the presence in its composition of combat assets of a unified battery command post “Rangzhir”, intended for automated control of combat operations of the “Tor-M1” air defense system as part of an anti-aircraft missile system
shelf.

The main purpose of the unified battery command post "Ranzhir" in relation to the Tor-M1 air defense system is to control the autonomous combat operations of anti-aircraft missile batteries (with setting and monitoring the implementation of combat missions by combat vehicles, target distribution between them, issuing target designations to them). Centralized control was to be carried out through a unified battery command post of the batteries of the Tor-M1 regiment from the regimental command post, which was supposed to use the MP22-R command and staff vehicle and the MP25-R special vehicle. The combat vehicle of the Tor complex can be transported by all types of transport, including aviation (chassis weight is 34,250 kg, the

maximum speed of the combat vehicle on paved roads is 65 km/h).

Mobile version of "Gor-LN TA"

Work is underway to replace the Minsk tracked chassis GM-355 with the GM-5955 developed in Mytishchi near Moscow.

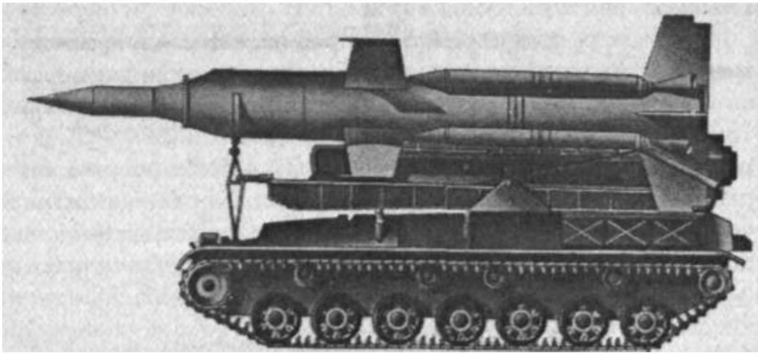
Work is also being carried out to place the main elements of the complex on wheelbases - in the self-propelled version "Tor-M1 TA" with the placement of the equipment cabin on the Ural-5323 vehicle, and the antenna-launching post on the 4MZAP8335 trailer , and in a towed “Tor-M1 B” (on two trailers). By reducing off-road capability and increasing the deployment (collapse) time to 8-15 minutes, the cost of the complex is reduced. Work is also underway on a stationary version of the Tor-M1 TS complex.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum	12.0
minimum	0.5
Damage height, km:	
maximum	6.0
minimum	0.01
Probability of target hit type aircraft with one missile	0.45—0.8
Number of target channels	
9M330 missile length, m	2
9M330 missile body diameter, m	2.89
Wingspan, m Weight,	0.23 0.65
kg: missile	
	165.0
warhead, kg	14.8
Reloading time, min	18

"Circle"

(RUSSIA)



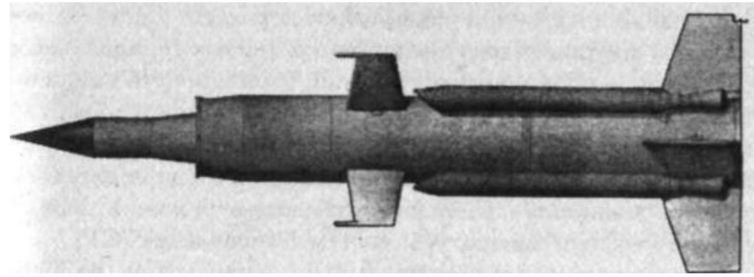
The self-propelled anti-aircraft missile system "Krug" (SA-4 "Ganef" according to the US/NATO classification) is designed to destroy air targets at ranges of up to 50 km.

The development of the complex began in 1958. The lead organization was determined to be NII-20 of the State Committee for Defense Equipment (GKOT), and V.P. Efremov was appointed chief designer. The 1S32 missile guidance station of the Krug complex was developed at the same NII-20 by chief designer I.M. Drize.

The KS-40 (ZM8) rocket, weighing 1800 kg with a ramjet engine, was to be created by the team of OKB-8 of the Sverdlovsk National Economy, headed by L.V. Lyulev. The anti-aircraft guided missile uses a ramjet engine (ramjet) using non-aggressive liquid fuel. The ramjet engine uses oxygen from the air as an oxidizer, so the only fuel in the rocket tanks is kerosene. Ramjet engines were 5 times or more superior in specific thrust to rocket engines. For rocket flight speeds 3-5 times higher than sound, the ramjet was characterized

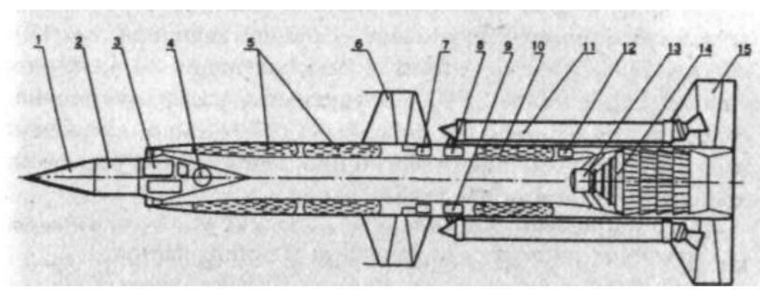
lowest fuel consumption per unit of thrust.

Taking into account the impossibility of ramjet operation at low speeds, the ZM8 rocket is designed according to a two-stage design. To ensure the conditions for launching a ramjet engine, solid propellant boosters accelerate the rocket to a speed corresponding to the number M = 1.5-2.



Anti-aircraft guided missile ZM8 SAM "Krug"

The requirement to implement transverse overloads of the order of eight units largely determined the choice of the general design of the rocket. For the second (propulsion) stage, a design with a rotating wing was adopted, which ensures the creation of sufficient lifting force at small angles of attack of the rocket body. The body of the rocket's sustainer stage itself is a supersonic ramjet engine ZTs4 - a tube with a pointed central body, ring nozzles and combustion stabilizers. In the central body of the air intake with a cylindrical part diameter of 450 mm, in addition to the ZN11 high-explosive fragmentation warhead weighing about 150 kg, there is a ZE26 radio fuse and a ball cylinder of an air pressure accumulator. A homing head was supposed to be installed in the front part of the central body. The central body is slightly



Layout of the ZM8 missile for the Krug air defense system:

1 - fairing; 2 - warhead; 3 - radio fuse; 4 - air pressure accumulator; 5 - fuel tanks; b - rotary wing; 7 - steering gear; 8 - radio control equipment; 9 - autopilot; 10 - isopropyl nitrate tank; 11 - starting accelerator; 12 - turbopump unit; 13 - nozzle block; 14 - combustion stabilizer; 15 - stabilizer.

deep into the internal volume of the rocket body. Next is the openwork structures are laid from annular and radial elements - straightening grilles, nozzle blocks, combustion stabilizers. In the annular engine housing with an outer diameter of 850 mm, starting from its leading edge, there are tanks with kerosene, approximately in the middle of the length - steering gears, wing fastenings, and closer to the trailing edge - blocks of control system equipment (CS).

Rotary wings with a span of 2.2 m were placed in an X-shaped pattern and could be deflected by a hydropneumatic steering drive in the range of 28°. Stabilizers with a span of 2.8 m are installed in a “+”-shaped pattern. The length of the rocket is 8.4 m, diameter - 850 mm. The launch mass of the rocket is 2455 kg, the initial mass of the

second (flight) stage is about 1400 kg, of which approximately 270 kg is kerosene and 27 kg is isopropyl nitrate.

The fuel supply is provided by a turbopump unit - volume running on monofuel - isopropyl nitrate.

Each of the four starting engines ZTs5 is equipped with a charge of 4L11 RSI-12K solid ballistic fuel weighing 173 kg in the form of a single-channel block. To ensure separation of the starting engines from the sustainer stage, a pair of small aerodynamic surfaces located at an angle to the longitudinal axis of the engine are fixed on each of them in the aft and bow sections.

On the ZM8 missile, the use of combined control was initially envisaged - a radio command system during the main flight phase and homing at the final part of the missile defense trajectory. The semi-active radar homing head was supposed to work by reflected

from the target to the signal of the pulsed radiation of the channel accompanying targeting the missile guidance station.

Missiles are launched from a self-propelled launcher (PU) KS-41 (2P24), located on the tracked chassis of a self-propelled artillery unit SU-100P.

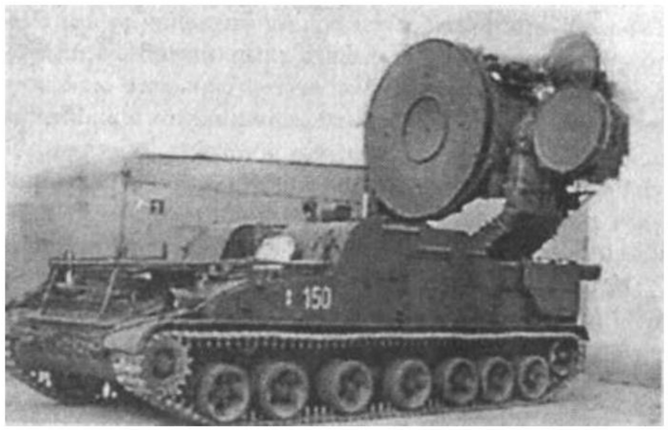
The artillery part of the launcher includes a support beam with a boom hinged in its tail section, raised by means of two hydraulic cylinders. Brackets with supports are attached to the sides of the boom - guides

"zero length" - to accommodate two missiles. When the rocket launches, the front support clears the way for the passage of the lower console of the rocket stabilizer. On the march the kets were held by additional supports, also secured mounted on the boom: one support was brought in front and ensured the fixation of both missiles at once, one more the support was moved from the sides opposite to the arrow.

Missiles are launched when the boom is raised from the direction lying at an angle from 10 to 60° to the horizon.

For radio command control of the missile defense system, a missile guidance station (SNR) 1S32 is used, which is a coherent-pulse RAS of the centimeter range (H-band). The station's antenna post is a complex rotating structure, the largest element of which is the target channel antenna. Left

from it there is a narrow beam antenna of the missile channel, above which there is a wide beam antenna of the missile channel, and closer to the periphery is the antenna of the command transmitter for the missile. Subsequently, a television-optical viewfinder camera was placed in the upper part of the antenna post. The station automatically processes target designation information received via telecode from the 1S12 target detection station (SOTs) and performs a quick target search. The search is carried out only by elevation angle, since the resolving method is



Missile guidance station 1S32

The effectiveness of a target detection station in the vertical plane is significantly less than in the horizontal plane. After detecting a target, it is captured for automatic tracking based on angular coordinates and range. The counting and deciding device

at the missile guidance station determines the boundaries of the launch and engagement zones, the installation angles of the acquisition and tracking antennas of the missile defense system (with wide and narrow scanning beams), as well as the data entered into the auto-range number of the target and missile. According to commands transmitted via telecode from the missile guidance station, the launcher is turned in the direction of launch. After the target enters the launch zone and the command transmitter is turned on at the missile guidance station, the missile is launched. The missile defense system is captured for tracking by signals from the missile transponder by the angular (with a wide beam) and rangefinder systems of the missile channel of the missile guidance station and is introduced first into the narrow beam of the missile channel antenna, and then into the beam of the target channel antenna. As a result, the electrical axes of both antennas are placed parallel. Flight control commands are transmitted on board the missile, generated by the missile guidance station's calculating instrument when the missile defense system deviates from the direction of the target, as well as a one-time command to remove the radio fuse from safety. SAM

guidance is carried out using the “half straightening” method or the “three points” method. The radio fuse is triggered when the missile flies less than 50 m from the target, otherwise the missile self-destructs.

The 1S32 station implements a method of hidden monoconical scanning along angular coordinates and an electronic target range finder. Noise immunity is ensured by the lettering of the channels, the high energy potential of the transmitter, as well as the coding of control signals.

The pulse power of the missile guidance station was 750 kW, the sensitivity of the receiver was 10 W, and the beam width [13] was 1°. Target acquisition for automatic tracking in a noise-free environment is carried out at a range of up to 105 km. At a given level of passive interference (1.5-2 packs of dipoles per 100 m of target path), the auto tracking range is reduced to 70 km.

Errors in target tracking in angular coordinates did not exceed 0.3 d.u., in range - 15 m. To protect against Shrike-type missiles, intermittent operating modes were introduced. The missile guidance station is located

on a chassis similar to the launcher chassis. The anti-aircraft missile division, armed with the Krug air

defense system, includes a 1S12 centimeter range (E-band) target reconnaissance station mounted on the chassis of a heavy AT-T artillery tractor. The same station, under the designation P-40 (“Armor”), was also used in the radar companies of military air defense. It provides detection of a fighter at ranges of up to 180 km (at a flight altitude of 12 km) and a target flying at an altitude of 0.5-70 km. The pulsed radiation power of the station is 1.7–1.8 MW, the sensitivity of the receiver is 4.3–7.7x10-14 W. With a circular view, 4 beams are sequentially formed in the elevation plane: two lower ones with a width of 2° and 4°, as well as two upper ones with a width of 10° and 14°. The beam direction is switched electromechanically.

Built-in gas turbine units with a capacity of 40-120 hp are used as power sources at the station. Information exchange between these means

Target reconnaissance station *1S12*

was provided by radio-telecode communication, which made it possible to sharply reduce the time spent on deployment/collapse at a combat position. The anti-aircraft missile division includes a control platoon, three anti-

aircraft missile batteries, each of which included one 1S32 missile guidance station and three 2P24 launchers with twin guides, as well as a technical battery. The control platoon contains a 1S12 target detection station, as well as a target designation receiving cabin for the Krab (K-1) combat control complex. The technical battery includes automotive stations for monitoring, maintenance and repair of combat vehicles

complex, transport and transport-charging vehicles, refueling vehicles, as well as technological equipment for assembling and refueling rockets. The anti-aircraft missile division is capable of conducting independent combat operations, but the 1S12 reconnaissance

station has

limited capabilities taking into account its actual placement in areas with shading areas.

To ensure more effective use of anti-aircraft missile divisions, they were included in the anti-aircraft missile brigades with a unified control system.

A brigade designed to solve air defense tasks of the front (army), along with three anti-aircraft missile divisions including included a control battery. The brigade's control battery contained the combat control cabin of the "Crab" complex, as well as its own means of detecting air targets, detection radar P40D, P-18, P-19, radio altimeter PRV-9A (or PRV-11).

Joint work of brigade and division command posts Zions were provided by the K-1 ("Crab") control complex.

Joint tests of the Krug complex were carried out from February 1963 to June 1964 at a newly formed test site near Emba station.

The complex was put into service in October 1964. Most of the requirements for the main characteristics were met. The range of destruction ranged from 11 to 45 km, the maximum heading parameter (removing the route

targets from the SAM position in the lateral direction) - 18 km. For the maximum target speed of up to 800 m/s, the initial requirements were exceeded by 200 m/s. The detection range of an object with an EPR corresponding to the MiG-15 was 115 km. A typical target (F-4C or F-105D fighter-bomber) was hit with a probability of 0.7. The reaction time of the complex was 60 s. Along with the adoption of the complex for service, work was carried out to further improve it, which was carried out in several stages. First of all, taking into account the experience of the Vietnam War, improvements were made to reduce the "dead

zone". In 1967, the Krug-A air defense system was put into service, for which the lower limit of the affected area was reduced from 3 km to 250 m, and the closest limit of the affected area was brought closer from 11 to 9 km. After modifications were made, the missiles were adopted into service with the Krug-M air defense system in 1971. The far border of the affected area of the complex was removed from 45 to 50 km, the upper one was raised

Launcher 2P24

from 23.5 to 24.5 m. In 1974, the Krug-M1 was put into service, for which the lower limit was reduced from 250 to 150 m, the near limit was reduced to 6-7 km. It became possible to hit targets on catch-up courses at a range of up to 20 km. Further expansion of the capabilities of the Krug complex was associated with the improvement of its combat control means.

leniya.

The "Crab" complex was initially developed mainly to ensure control of combat operations of anti-aircraft artillery units and, when used as part of brigades of the "Krug" complex, had a number of disadvantages:

- mixed control mode (the most effective in a real combat situation) was not provided;
- there were significant limitations on the capabilities of target designation (one target was given instead of the required 3-4); • information from divisions about independently selected targets could not be transmitted to the brigade command post;

reptiles;

- the brigade command post was technically interfaced with higher air defense units (air defense command posts of the front and army) only through radiotelephone channels and a tablet data exchange scheme, which led to a delay of an average of 40 s and a loss of up to 70% -ley; the division command post, when receiving information from its own target detection station 1S12, delayed the passage of target designation to the batteries and lost up to 30% of targets; • the range of radio links was insufficient, amounting to 15-20 km instead of the required 30-35 km; complete

All used only a telecode communication line between the command posts of the brigade and divisions with insufficient noise immunity. As a result, the fire capabilities of the Krug brigade were

used only by 60%, and the degree of participation of the brigade command post in organizing the repulsion of the raid was less than half of the targets fired at. In the 70s, an automated control system (ACS) for the combat operations of the Krug anti-aircraft missile brigade Polya-na D1 was developed.

Joint tests of the Polyana D1 automated control system were carried out from April to June 1980, and in 1981 it was put into service. Compared to the "Crab" complex at

the brigade command post, the number of simultaneously processed targets increased from 10 to 62, and simultaneously controlled target channels - from 8 to 16. At the division command post, the corresponding indicators increased from 1 to 16 and from 1 to 4, respectively . The Polyana D1 automated control system was the first to automate the processes of coordinating the actions of subordinate units on targets they independently selected, issuing information about targets from subordinate units, identifying targets and preparing the commander's decision.

The brigade combat control point (PBU-B) 9S478 includes a 9S486 combat control cabin, a 9S487 interface and communications cabin and two diesel power plants.

The division combat control point (PBU-D) 9S479 consists of a 9S489 combat control cabin and a diesel-electric stations.

In addition, the automated control system includes started the maintenance cabin 9ÿ488.

All cabins and power stations PBU-B and PBU-D were placed on the chassis of Ural-375 vehicles with a unified body - a K1-375 van. The exception was the UAZ-452T-2 topo-tie as part of the PBU-B. Topographical reference of PBU-D was provided by appropriate means of the division. Communication between the front (army) air defense command post **and PBU-B, and** between PBU-B and PBU-D, was carried out via telecode and radiotelephone channels. PBU-B was equipped with radars (P-40D, P-18, P-19, PRV-16, PRV-9A), operating in different frequency ranges and having cable connections with **PBU-B.** PBU-B automatically ensures the distribution of targets between PBU-D and the setting of fire missions, taking into account target designations

from higher command posts, coordination of the shelling of targets by anti-aircraft missile divisions, as well as receiving commands from higher command posts and transmitting reports to them.

PBU-D technical means provide:

- reception and display of primary information from the division's 1S12 target detection station with semi-automatic

taking coordinates and processing data on eight targets, as well as automatic reception and display of data on. purposes transferred from PBU-B; • automatic height determination based on 1C12 viewing areas; • transmission of control commands and control center data to batteries (missile guidance stations) (up to four targets based on one target per battery);

• receiving and displaying reports from batteries about the position, condition, combat readiness, combat operations and firing results, as well as the previously described interaction with the combat control point and the brigade. The operation of PBU-B was ensured by a crew of 11 people.

century, PBU-D - 7 people. Evaluations of performance indicators showed that the introduction of the Polyana D1 automated control system increases the mathematical expectation of targets destroyed by a brigade by 21%, and reduces the average missile consumption by 19%. In addition to these measures to improve the Krug air defense system, work was also carried out to give the Krug complexes versatility - the ability to combat both aircraft and tactical and ballistic missiles.

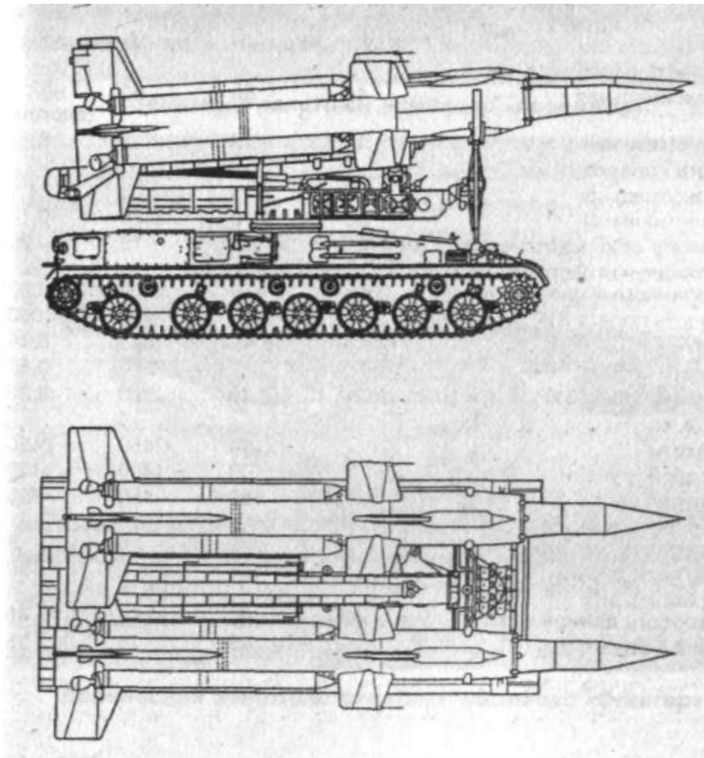
operational-tactical purposes.

On the basis of the Krug air defense system, an experimental model of the Krug-M anti-aircraft missile system was developed, designed to combat both aircraft and ballistic missiles Onest John, Lance, Corporal and Sergeant.

The radio command guidance system of the Krug air defense missile system was supplemented by means of providing homing when the missile approaches the target based on the target illumination radar transmitter from the Kub self-propelled reconnaissance and guidance system and the Doppler semi-active radar homing head of the ZM9 missile of this complex. A new directional warhead was installed on the ZM8 type missile. Thus, at a new turn of the development spiral, the original combined guidance system of the ZM8 missile was restored, but this time with a significant difference: target illumination was provided not by the pulse missile guidance station of the Krug air defense system, but by the illumination channel of the self-propelled reconnaissance and guidance system of the complex "Cube" operating in continuous radiation mode. As a result, a certain

success. At the Embensky training ground, R-11M (8K11) missiles were launched in the direction of the air defense missile system at a range of LO-100 km. The standard radar systems of the Krug air defense system successfully solved their tasks: the ballistic missile with a length of about Im and a diameter of 0.88 m was detected by the 1S12 target detection station and was taken for auto tracking by the 1S32 missile guidance station. It ensured that the missile defense system was aimed at the target and that the radio fuse was triggered, covering the target with a field of fragments, which opened up the possibility of equipping troops with a universal air defense system capable of hitting ballistic missiles with a launch range of up to 150 km. But by this time it was already necessary to ensure the interception of the Pershing ballistic missile with a launch range of up to 740 km. The detachable warhead (warhead) of the Pershing missile had a significantly higher speed (about 3 km/s versus 2 km/s for the R-11M) and, most importantly, the ESR was only

hundredths of a square meter - an order of magnitude less than



ballistic missiles with an inseparable warhead, and two orders of magnitude less than that of a fighter aircraft. At the end of the

60s, the development of a new universal (anti-aircraft and anti-missile) complex S-ZOOV began, designed to intercept all types of operational-tactical missiles, including the Pershing ballistic missile. In this regard, work on creating a universal version of the Krug-M complex was stopped. In 1971, an anti-aircraft air defense system under this name was put into service.

For the air defense of a number of anti-submarine and missile-carrying ships of the Navy, starting in 1959, the M-31 air defense system was developed, the characteristics of which corresponded to the Krug air defense system. The KS42 missile used was created on the basis of the ZM8.

The complex was supplied to Bulgaria (27 air defense systems), Hungary (18), and Poland.

TACTICAL AND TECHNICAL CHARACTERISTICS

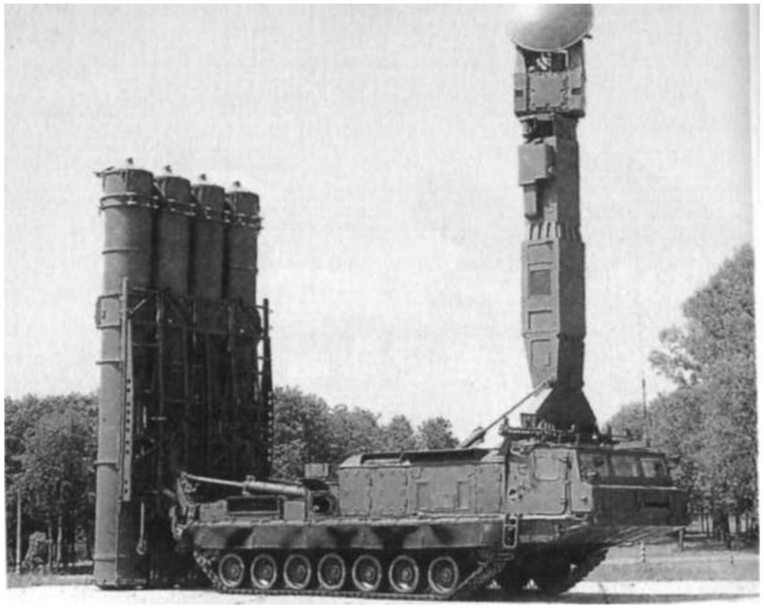
	"Circle"	"Circle-A"	"Circle-M"	"Circle-M 1"
Damage range, km:				
maximum	45	50	50	50/20 (to catch up)
minimum	eleven	9	9	6—7
Damage height, km:				
maximum	23.5	23.5	24.5	24.5
minimum		0.25	0.25	0.15
Maximum target parameter, km	3" 18	18	18	20

Maximum speed
targets hit, m/s 800 800 800—800 1000 SAM flight speed, m/s
800— 1000 800— 1000 800— 1000 800— 1000 SAM length, m 8.44 8.44 SAM
diameter, m 0.85 0.85 SAM wingspan, m 2 ,20 2.20 Weight, kg: missiles of the second 8.44 8.44
stage of the warhead Roll-up (deployment) time , min SAM cruising range, km Maximum 0.85 0.85
speed, km/h Armor thickness, mm 2.20 2.20

2450	2450	2450	2450
1400	1400	1400	1400
150	150	150	150
5 450	5 450	5 450	5 450
45	45	45	45
15	15	15	15

Anti-aircraft missile system "Avenger"

Man-portable anti-aircraft missile system "Stinger"



S-ZOOV air defense missile system launcher

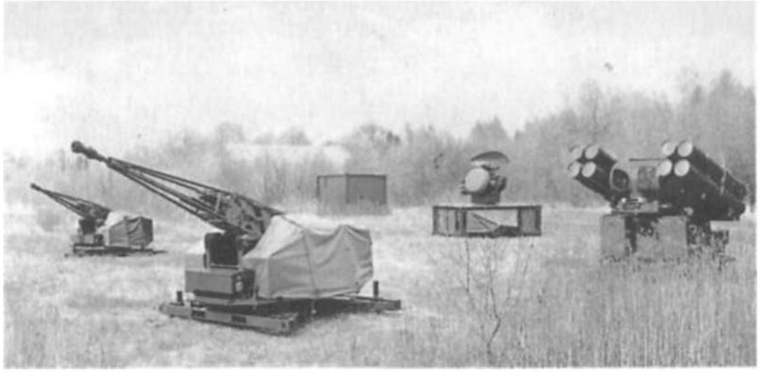
Launch of the Strela-10 air defense missile system

Anti-aircraft missile system **LAV-AD**

Anti-aircraft missile system ADATS

Anti-aircraft missile system "Rapira"

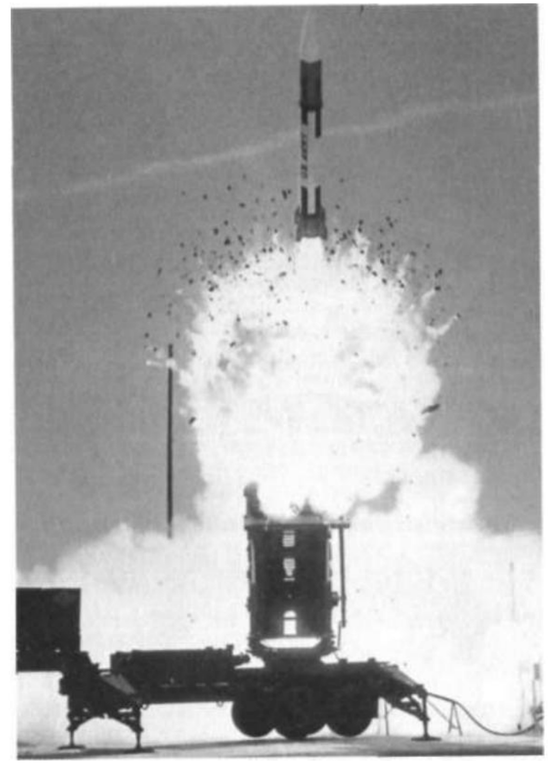
Anti-aircraft missile system "Buk"



Anti-aircraft missile and artillery complex "Skyshield-ADATS"

Anti-aircraft missile system "Osa" on the march

Launch of the Osa air defense missile system



Missile launch using the Patriot complex

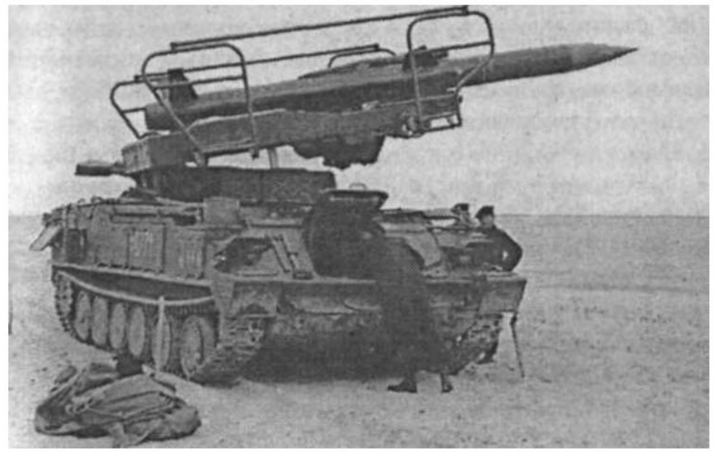
Control point for air defense unit of motorized rifle regiment 9S80-1

Anti-aircraft missile system S-125 "Newa-SC"

Anti-aircraft *missile* system *"Poland"*

***ZPRK "Tunguska"* on the march**

"Cube"
(RUSSIA)



Self-propelled short-range air defense system "Cube" (SA-6 "Gainful" but US/NATO classification) is designed to destroy planes and helicopters flying on collision courses and catch up

The creation of the complex began in 1958 (the main developer was the V.V. Tikhomirov Research Institute of Instrument Engineering). It was adopted for service in January 1967. In the same year The complex was demonstrated during a military parade in Moscow. The export version

of the complex was named “Square”. The "Cube" complex was supposed to

ensure the destruction of air targets flying at speeds of 420-600 m/s at altitudes from 100-200 m to 5-7 km at ranges of up to 20 km with the probability of hitting a target with one missile not less than 0.7.

The main combat assets of the complex are the 1S91 self-propelled reconnaissance and guidance unit (SURN) and the 2P25 self-propelled launcher (SPU) with ZM9 missiles.

The 1S91 self-propelled reconnaissance and guidance system (according to NATO terminology - “Straight Flush”) includes two radar stations - the 1S11 air target detection and target designation radar and the 1S31 target tracking and illumination radar - as well as means that ensure target identification , navigation, topographical reference, relative orientation, radio telecode communication with self-propelled launchers, television-optical sight, autonomous power supply (a gas turbine electric generator was used), antenna lifting and leveling systems. The equipment of the self-propelled reconnaissance and guidance system is located on the GM-578 chassis. The radar antennas are located in two tiers (the 1S31 station antenna is on top, the 1S11 station antenna is below) and can rotate in azimuth independently of each other. To reduce height

chassis on the march, the cylindrical base of the antenna devices is retracted inside the body of the tracked vehicle, and the antenna device of the 1S31 radar is turned down, located behind the antenna of the 1011 station.

Based on the desire to provide the required detection range with a limited power supply, taking into account the size and mass restrictions for the 1S11 station and target tracking in the 1S31 station, a coherent-pulse radar scheme was adopted. The continuous radiation mode was implemented

when illuminating a target when a missile is flying at low altitudes in conditions of powerful reflections from the underlying surface for stable operation of the homing head.

Station 1S11 is a coherent-pulse all-round radar (viewing speed - 15 rpm) in the centimeter range with two independent operating

at spaced carrier frequencies by waveguide transmitting and receiving channels, the emitters of which were installed in the focal plane of a single antenna mirror. Obna-

arming, target identification and target designation of the tracking and illumination station is ensured when the target is located at ranges from 3 to 70 km and at altitudes from 30 to 7000 m with a pulsed radiation power of 600 kW in each channel, receiver sensitivity of the order of - whose azimuth is about 1 and the total viewing sector in angle

13

°

places about 20°. To ensure noise immunity, the 1S11 station was equipped with: • moving target selection and suppression systems;

elimination of asynchronous impulse noise;

- manual gain adjustment of receiving channels;
- pulse repetition frequency modulation; • frequency tuning of transmitters.

The 1S31 station also consists of two channels with emitters installed in the focal plane of the parabolic reflector of a single antenna - target tracking and target illumination. According to the target tracking channel, the station has a pulse power of 270 kW, a receiver sensitivity of about 10 W, and a beam width of about 1°. The station can auto-track a Phantom-2 type aircraft with a probability of 0.9 at a range of up to 50 km. Protection against passive interference and ground reflections is carried[13] out by the SDC system with a programmatic change in the pulse repetition frequency, and against active interference - using the method of single-pulse target direction finding, an interference indication system and adjustment of the station's operating frequency. In the event that the 1S31 station is nevertheless suppressed by interference, you can resist

guide the target along angular coordinates using a television optical sight, and information about the range

Self-propelled reconnaissance and guidance unit 1S91

part from radar 1S11. The station provides special measures for sustainable tracking of low-flying targets. The transmitter for illuminating the target (and irradiating the missile seeker with a reference signal) generates continuous oscillations and ensures reliable operation of the missile seeker.

The weight of a self-propelled reconnaissance and guidance system with a combat crew of 4 people is 20.3 tons. The 2P25 self-propelled launcher, located on the GM-578 chassis, is equipped with a carriage with three guides

for rockets and electric power tracking drives, a counting device, equipment for navigation, topo-binding, telecode communication, pre-launch control of rockets, an autonomous gas turbine electric unit. Pre-launch guidance of missiles in the direction of the pre-emptive meeting point of the missile with the target is carried out by the carriage drives, which process data from the self-propelled reconnaissance and guidance unit.

information that arrives at the self-propelled launcher via a radio telecode communication line.

In the transport position, the missile defense system is located at the tail part forward along the self-propelled launcher.

Weight of a self-propelled launcher with three missiles and with a combat crew of 3 people on board is 19.5 tons.

The ZM9 missile is made according to the "rotary wing" design. However, unlike the ZM8 missile of the Krug complex, the ZM9 missile defense system additionally uses rudders located on the stabilizers for control. As a result of the implementation of this scheme, it was possible to reduce the size of the rotary wing, reduce the required power of the steering machines and use a lighter pneumatic drive instead of a hydraulic one.

equal.

The missile ensures the destruction of targets maneuvering with an overload of up to 8 g, but at the same time the probability of their destruction is reduced to 0.2-0.55, while the probability of hitting non-maneuvering targets is in the range of 0.4-0.75.

The length of the ZM9 rocket is 5.8 m, diameter is 0.33 m, wingspan is 1.245 m, launch weight is 599 kg. The 1SB4 semi-active radar homing head locks onto a target from the start and tracks it using Doppler frequency in accordance with the missile's closing speed

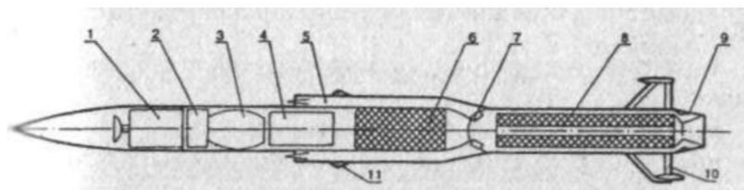
with the target and generates control signals for aiming the missile defense system at the target. The homing head's protection from intentional interference is ensured by a hidden frequency target search and the ability to homing to the source of interference and amplitude mode of operation. The seeker is located in front of the rocket, followed by the combat part, and then - the autopilot equipment and the engine.

The rocket is equipped with a combined propulsion system. In front there is a gas generator chamber with a charge of the 9D16K sustainer (second) stage engine. The nominal operating time of the engine is slightly more than 20 s, the mass of the fuel charge (760 mm long) is about 67 kg. The combustion products of the gas generator charge enter the

an afterburner chamber where the remaining fuel burns in a stream of air entering through 4 air intakes. At the launch site, before the main engine is turned on, the exits of the air intake ducts into the afterburning chamber are closed with glass

plastic plugs.

The afterburning chamber houses the solid propellant charge of the starting stage - a conventional block of ballistic fuel VIK-2 weighing 172 kg with armored ends (1.7 m long and 290 mm in diameter, with a cylindrical channel with a diameter of 54 mm). Since the gas-dynamic operating conditions of the solid propellant engine in the launch section and the ramjet in the sustaining section require different geometry of the afterburner nozzle, upon completion of the launch stage operation (duration 3-6 s), it is planned to shoot out the internal



Layout of the ZM9 missile for the Kub air defense system:

i GOS; 2 - radio fuse; 3 - warhead; 4 - autopilot; 5 - air intake; 6 - gas generator; 7 - plugs; 8 - fuel charges of the starting engine ; 9 - starting engine nozzle; 10 - stabilizer; 11 - wing.

the lower part of the nozzle apparatus with a fiberglass grid that holds the starting charge. The starting charge ensures acceleration of the rocket to a speed of Ml.5, the inclusion and operation of the main engine (ramjet) allows the rocket to reach a speed of M2.8. It should be noted that it is in the ZM9 rocket | For the first time in the world, such a design was brought to the stage of serial production and adoption. Subsequently, after the organized theft by the Israelis of several ZM9 missiles during the 1973 war in the Middle East, the Soviet ZM9 missile served as a prototype for the creation of a number of foreign anti-aircraft and anti-ship missiles. The use of ramjet engines ensured that the ZM9 rocket maintained high speed throughout its entire trajectory, which contributed to its high maneuverability.

The ZN12 high-explosive fragmentation warhead weighing 57 kg is detonated at the command of a ZE27 two-channel continuous radiation radio fuse. Subsequently, a whole family of missiles based on the ZM9 was created, namely: ZM9M1, ZM9M2, ZM9MZ, ZM9MZA and ZM9MA. The total time for all combat operations (turning on the radar, detection, target acquisition for tracking, determining declaring its state affiliation, launching missiles and destroying a target on the far border of the affected area) the prepared combat crew performs in 3 minutes. The time for collapsing the complex to occupy a new position is about 15 minutes.

Immediately after the Cube complex was put into service, its modernization began. In January 1973, a modernized complex under the code “Kub-M1” was put into service. As a result of modifications, its combat capabilities were increased.

possibilities:

• the boundaries of the affected area have been expanded; • intermittent operation modes of the radar of a self-propelled reconnaissance and guidance system are provided for protection against Shrike-type anti-radar missiles; • increased protection of the seeker from distracting interference; • reliability indicators of air defense missile systems have been improved; • the operating time of the complex was reduced by approximately 5 s.

As a result of the following modernization of the air defense system (1974-76), a modification of the Kub MZ complex with significantly increased combat capabilities was created:

• the affected area is expanded;

• the ability to fire in pursuit at targets at speeds of up to 300 m/s and at stationary targets at altitudes above 1000 m is provided; • the average flight speed of missiles has been increased from 600 to 700 m/s; • ensured the defeat of aircraft maneuvering with over-loads up to 8g; • improved noise immunity of the seeker; • the near border of the affected area has been reduced; • increased by 10-15% the probability of defeat by maneuvering general goals;

• improved reliability of ground combat air defense systems and its performance characteristics. From 1967 to 1983, more than 500 air defense systems of the “Cube” family and several tens of thousands of missiles were produced. More than 4,000 missile launches were carried out during tests and exercises.

The "Cube" air defense system under the code "Square" was supplied to the armed forces of 25 countries (Algeria, Angola, Bulgaria, Cuba, Czechoslovakia, Egypt, Ethiopia, Guinea, Hungary, India, Ku-

Loading the launcher

veit, Libya, Mozambique, Poland, Romania, Yemen, Syria, Tanzania, Vietnam, Somalia, Yugoslavia, etc.). In 1998, a new option for modernizing the Krug complex was proposed. Instead of one 2P25 self-propelled launcher, a self-propelled firing system (SOU) was introduced into its composition. Two variants of a self-propelled firing system have been developed: SOU 9A38 with a unified launcher, allowing the use of both 3 missiles of the Kub air defense system, and 3 new missiles developed for the Buk air defense system, and SOU 9A310 with a launcher, allowing the use 4 Buk air defense missiles. The Kub air defense system with the 9A38 self-propelled gun was adopted by Russia under

code "Cube-M4".

All SOU equipment is developed on a modern element base and is manufactured using the latest technologies. This made it possible to significantly increase its reliability and service life. The use of digital computers for processing SOU information made it possible to simplify the work of operators and reduce the SOU crew to 3 people instead of 4 in a self-propelled reconnaissance and guidance installation. Noise and vibration levels have been reduced and air conditioning has been installed.

Introduction of SOU into the Kub air defense system instead of one of the SPU 2P25 allows:

- double the number of fire channels;
- significantly increase noise immunity and protection from anti-radar missiles;
- when using the latest Buk air defense missiles, significantly increase the number of types of targets hit and their zones lesions;
- during autonomous operation of the SOU, move it to the most dangerous directions, while defining response zones property.

Due to the introduction of a target type recognition system into the control system By analyzing the spectrum of the reflected signal, the installation is capable of highly effective hitting not only aerodynamic, but also some ballistic targets, as well as helicopters, including hovering ones. The latest improvements made to the SOU 9A310M1 also make it possible to fire at ground-based radio-contrast targets.

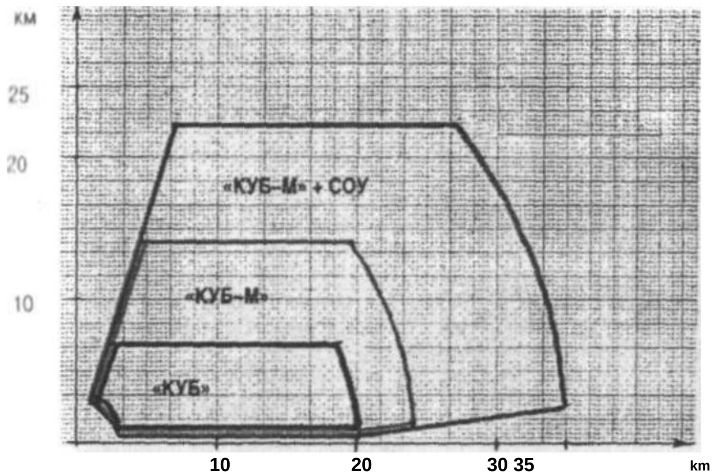
Impact zone for targets with an effective surface-launched launcher dispersion power of at least 1 m^2, with a Buk air defense missile is:

- in height - from 15 m to 22 km (instead of 25 m and 14 km for SAM "Cube");
- in range - from 3 to 35 km at a speed of 830 m/s (instead of 4–24 km at a speed of 600 m/s of the Kub air defense system). It is considered

advisable to give the “Cube” complex, together with the SOU, a launch-loading unit (PZU), which has 8 missiles (4 are ready for combat use, and 4 are in the transport position).

The “Cube” (“Square”) complex was successfully used in almost all military conflicts in the Middle East. Its first combat use occurred from October 6 to October 24, 1973, when 95 missiles of the “Kvadrat” complex, according to the Syrian side, shot down 64 Israeli aircraft. The exceptional effectiveness of the Kvadrat air defense system was determined by several factors:

- high noise immunity of complexes with semi-active homing;
- the lack of radio-electronic countermeasures equipment on Israeli aircraft that operates in the required range



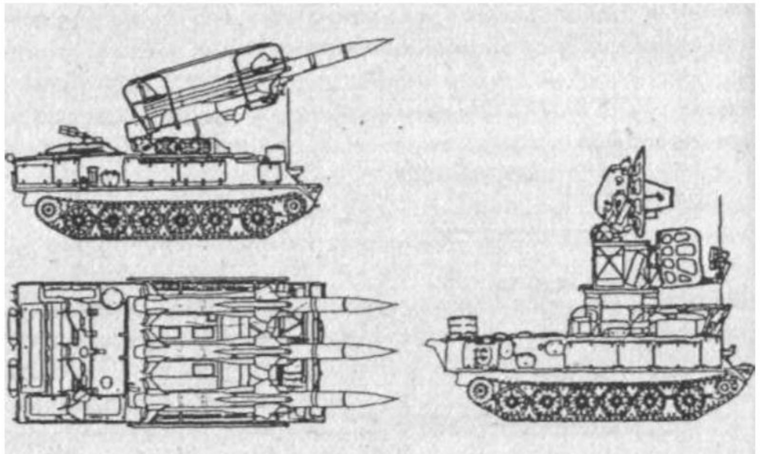
Damage zones of the "Cube" air defense system

frequency range (equipment supplied from the USA was designed to combat the previously used S-75 and S-125 radio command air defense systems operating at longer wavelengths); • high probability of hitting the target
with maneuverable missiles |
with direct-flow motor. Without
the technical means to suppress the Kvadrat air defense system, Israeli aviation was forced to use rather risky tactics. The Israelis used multiple entries into the launch zone followed by a hasty exit from it in order to quickly consume the complex's ammunition and then destroy the disarmed air defense system. In addition, the fighter approach was used -

-bombers at altitudes close to their service ceiling, with further diving into the "dead zone" funnel above the air defense system.

The high efficiency of the Kvadrat air defense system has been confirmed | in the period from March 8 to May 30, 1974, when up to 6 aircraft were destroyed by launches of 8 missiles.

The "Kvadrat" complex was used during the fighting in Lebanon in 1981-82, during conflicts on the Algerian-Moroccan border, between Egypt and Libya, when repelling the American



Самоходная пусковая установка 2П25

Самоходная установка разведки и наведения 1С91

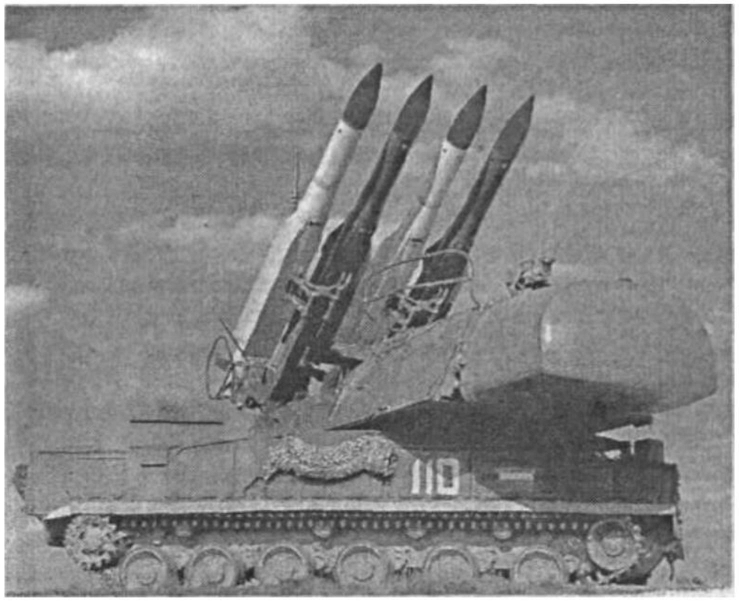
Rican raids on Libya in 1986, in Chad in 1986-87, in Goslavia in 1999. In 1995, during the fighting in Bosnia, the Bosnian Serbs destroyed an American F- fighter with this complex 16.

TACTICAL AND TECHNICAL CHARACTERISTICS

	"Cube"	"Cube-M1"	"Cube-MZ"	"Cube-M4"
Damage range, km:				
maximum	22.0	23.0	25.0	24.0
minimum	6.0—8.0	4.0	4.0	4.0
Damage height, km:				
maximum	7.0(12.0) 8.0(12.0) 8.0(12.0) 0.1			14.0
minimum	0.03 0.02			0.03
by parameter	to 15 to 15.0 to 18.0 to 18.0			
Probability of being hit by one missile:				
fighter	0.7 0.8—0.95 0.8—0.95 0.8—0.9 0.3—			
helicopter				0.6 0.25
cruise missile				—0.5
Maximum target				
speed, m/s Reaction	600 600 600 26—28 22—24			600
time, s Missile flight	22—24 600 600 700 630 630 630			24
speed, m/s Weight, kg Weight	57 57 57 1 1 1 2—3 2—3			700
of				630
warhead, kg Channel to				57
target Channel to missile				
2-3				2 to 3
deployment (collapse) time , min				
Number of missiles on a	5	5	5	5
combat vehicle	3	3	3	3

"Beech"

(RUSSIA)



The self-propelled military air defense system "Buk" (SA-11 "Gadfly") is designed to combat maneuvering aerodynamically-
against targets at low and medium altitudes, in conditions of radio countermeasures, and in the future - with Lance-type ballistic missiles. Development, which began
in 1972, involved the use of cooperation between developers and manufacturers, previously involved in the creation of the Kub air defense system. At the same time, the development of the M-22 ("Hurricane") air defense system for the Navy was determined using a missile defense system common to the Buk complex.

The developer of the Buk (9K37) air defense system was generally identified as the Instrument Engineering Research Institute of the Phazotron Research and Design Association. A. A. Rastov was appointed chief designer of the complex.

The development of missiles was entrusted to the Sverdlovsk machine-building design bureau "Novator", headed by L. V. Lyulev. Detection and targeting station (SOC)

was developed at the Research Institute of Measuring Instruments under the leadership of chief designer A.P. Vetoshko (then Yu.P. Shchekotov).

Start-up loading units (ROM) were created at the Start mechanical engineering design bureau under the leadership of A.I. Yaskin. A set of technical support and
maintenance tools for the vehicle was also developed for the complex.

new chassis.

Completion of the development of the complex was planned for 1975. However,
in 1974, it was decided to create the Buk air defense system in two stages. It was initially proposed to rapidly develop a missile defense system and a self-propelled firing system for the Buk air defense system, capable of launching both 9M38 missiles and ZM9MZ missile defense systems from the Kub-MZ complex. On this basis, using other means of the Kub-MZ complex, it was planned to create the Buk-1 (9K37-1) air defense system, ensuring its entry into joint testing in September 1974, maintaining the previously prescribed volumes and timing of work on the complex "Buk" in full force. For the Buk-1 air defense system, it was envisaged as part of each of the five anti-
aircraft missile batteries of the Kub-MZ regiment, in addition to one self-propelled reconnaissance and guidance unit and

four self-propelled launchers, have one 9A38 self-propelled firing system from the Buk air defense system. Thus, due to the use of a self-propelled firing system costing about 30% of the cost of all other battery assets in the Kub-MZ anti-aircraft missile regiment, the number of target channels increased from 5 to 10, and the number of combat-ready missiles - from 60 to 75. On the GM-569 tracked chassis, the 9A38 self-propelled firing system seemed to combine
the functions of a self-propelled reconnaissance and guidance installation and a self-propelled launcher used as part of the Kub-MZ air defense system. It provided search in an established sector, detecting

acquisition and acquisition of a target for automatic tracking, solving pre-launch tasks, launching and homing of three missiles on it (9M38 or ZM9MZ), as well as three ZM9MZ missile defense systems, positioning

connected to one of the self-propelled launchers 2P25MZ of the Kub-MZ air defense missile system. The combat operation of a self-propelled firing installation could be carried out both with control and target designation from a self-propelled reconnaissance and guidance installation, and autonomously. The 9A38 self-propelled

firing system includes a 9S35 radar station, a digital computer system, a starting device with a power tracking drive, a ground-based radar interrogator operating in the “Password” identification system, a television-optical viewfinder, telecode communication equipment with the self-propelled reconnaissance and guidance installation, wired communication equipment with a self-propelled launcher, an autonomous power supply system based on a gas turbine generator, navigation, topographical and orientation equipment, a life support system

cookies

The mass of a self-propelled firing system with a combat crew of four people is 34 tons.

Advances in the development of microwave devices, quartz and electromechanical filters, and digital computers have made it possible to combine the functions of target detection, tracking, and target illumination stations into the 9S35 radar. The station operates in the centimeter wavelength range using a single antenna and two transmitters - pulsed and continuous radiation. The first transmitter was used to detect and automatically track targets in

in a quasi-continuous mode of radiation or, if difficulties arose with unambiguous determination of the range, in a pulse mode with pulse compression (using linear frequency modulation), a second transmitter (continuous radiation) was used to illuminate the target and the missile defense system. The antenna system of the station conducts a sector search using an electro-mechanical method, tracking the target along angular

coordinates and range are performed using a monopulse method, and signal processing is performed by a digital computer. Chart width

directionality of the target tracking channel antenna composition -

is 1.3° in azimuth and 2.5° in elevation, the illumination channel is 1.4° in azimuth and 2.65° in elevation. Time to review the search sector (120° in azimuth and 6-7° in elevation) in autonomous

mode is 4 s, in control mode (10° in azimuth and 7° in elevation) - 2 s. The average transmitter power of the target detection and tracking channel when using quasi-continuous signals is at least 1 kW, when using signals with linear frequency modulation - at least 0.5 kW. The average power of the target illumination transmitter is at least 2 kW. The noise figure of the station's survey and direction-finding receivers did not exceed 10 dB. The transition time of the radar from standby mode to combat mode is no more than 20 s. The station is capable of unambiguously determining the speed of a target with an accuracy of -20...+10 m/s. Selection of moving targets is ensured. Maximum errors in range do not exceed 175 m, root-mean-square errors in measuring angular coordinates - no more than 0.5 d.u. The radar is protected from active, passive and combined interference. The equipment of the self-propelled firing system ensures blocking of the launch of missiles when accompanied by a friendly aircraft or helicopter. The 9A38 self-propelled firing system has a launcher with interchangeable guides for either three ZM9MZ missiles or three 9M38 missiles.

The 9M38 anti-aircraft missile is single-stage, has a dual-mode solid propellant engine (total operating time is about 15 s). The rejection of a ramjet engine was explained by the instability of its operation at high angles of attack and pain.

high resistance on the passive part of the trajectory, and

the complexity of its development, which largely determined the delay in the creation of the “Cube” complex. In the power con-

Metal is used in the engine chamber structure.

The general design of the rocket is normal, X-shaped, with a wing low elongation crowbar - outwardly resembled American naval anti-aircraft missiles of the Tartar and Standard families, which corresponded to the strict dimensional restrictions when using the 9M38 missile defense system in the M-22 complex, developed *for* the Soviet fleet.

In front of the rocket are placed sequentially semi-active homing head, autopilot equipment, power supplies and warhead. To reduce the dispersion of alignment over flight time, the combustion chamber of the solid propellant rocket engine is located closer to the middle of the rocket, the nozzle block is turned on

There is an elongated gas duct around which the elements are located.
steering gear.

Smaller diameter of the rocket's front compartment (330 mm) in relation to the engine and tail section is determined continuity of a number of elements of the ZM9 rocket. A new seeker with a combined control system was developed for the rocket. The complex implements self-guidance of missiles using the proportional navigation method.

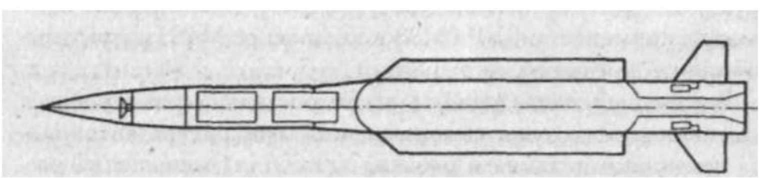
The 9M38 missile defense system can hit targets at altitudes from 25 m to 18-20 km at ranges from 3.5 to 25-32 km. The rocket has a flight speed of 1000 m/s and can maneuver with overloads of up to 19g.

The mass of the rocket is 685 kg, including the warhead - 70 kg. The design of the 9M38 missile ensures

its delivery to troops in a transport container in a fully equipped form, as well as operation without inspections or routine maintenance for 10 years. Tests of the Buk-1 air defense system took place from August 1975 to October 1976. As a result of the tests, the detection range of radar aircraft of a self-propelled firing system in

autonomous mode was obtained from 65 to 77 km at altitudes of more than 3000 m, which at low altitudes

(30-100 m) it decreased to 32-41 km. Helicopters at low altitudes were detected at a distance of 21-35 km. In the centralized mode of operation, due to the limited capabilities of the 1S91M2 self-propelled reconnaissance and guidance unit providing target designation, the aircraft detection range was reduced to 44 km for targets at altitudes of 3000–7000 m and to 21–28 km at low altitudes.



Layout of the 9M38 missile defense system "Buk"

The operating time of the self-propelled firing system in autonomous mode (from target detection to missile launch) was 24-27 seconds. The loading and unloading time for three ZM9MZ or 9M38 missiles was about 9 minutes.

When firing the 9M38 missile defense system, the destruction of aircraft flying at altitudes of more than 3 km was ensured at a range of 3.4 to 20.5 km, and at an altitude of 30 m - from 5 to 15.4 km. The affected area ranged from 30 m to 14 km in height, and 18 km in course parameters. The probability of an aircraft being hit by one 9M38 missile was 0.70-0.93.

The complex was put into service in 1978. Due to the fact that the 9A38 self-propelled firing system and the 9M38 missile defense system were means that only complemented the Kub-MZ air defense system, the complex was named “Kub-M4” (2K12M4).

The Kub-M4 complexes that appeared in the air defense forces made it possible to significantly increase the effectiveness of air defense of tank divisions of the ground forces of the Soviet Army. Joint tests of the Buk complex in its full specified

composition were carried out from November 1977 to March 1979. The combat assets of the Buk air defense system had the following characteristics:

teristics.

The 9S470 command post located on the GM-579 chassis provided: reception, display and processing of target information received from the 9S18 detection and target designation station and six 9A310 self-propelled firing systems, as well as from higher command posts; selection of dangerous targets and distribution

placing them between self-propelled firing installations manually in normal and automatic modes, setting their sectors in response property, displaying information about the presence of missiles on them and on launch-loading installations; about the letters of the illumination transmitters of self-propelled firing systems, about their work on targets; about the operating modes of the detection and target designation station; organizing the operation of the complex in conditions of interference and the enemy’s use of anti-radar missiles; documentation of work and training in calculation of CP. The command post processed messages about 46 targets at altitudes up to 20 km in a zone with a radius of 100 km per review cycle of the detection and target designation station and sent them to self-propelled fire

installation of up to 6 target designations with an accuracy of 1 in azimuth and elevation, 400-700 m in range. The weight of the command post with a combat crew of 6 people did not exceed 28 tons. Command post has bulletproof and anti-radiation protection and can Capable of reaching speeds on the road up to 65 km/h, on rough terrain - up to 45 km/h. Power reserve - 500 km.

Detection and target designation station 9S18 (“Dome”) - three-coordinate coherent-pulse - operates in centimeter meter wave range, has electronic scanning of the beam in elevation (in a sector of 30 or 40°) and mechanical (circular or in a given sector) rotation of the antenna in azimuth (using an electric or hydraulic drive). The station is designed to detect and identify air targets at ranges up to 110-120 km (45 km at a flight altitude of 30 m) and transmit information about the air situation to the 9S470 control post. The rate of viewing the space, depending on the established sector in elevation and the presence of interference, ranged

from 4.5 to 18 s for all-round viewing and from 2.5 to 4.5 s for viewing in a 30° sector. Radar information is transmitted via telecode line to the 9S470 CP in the amount of 75 marks per

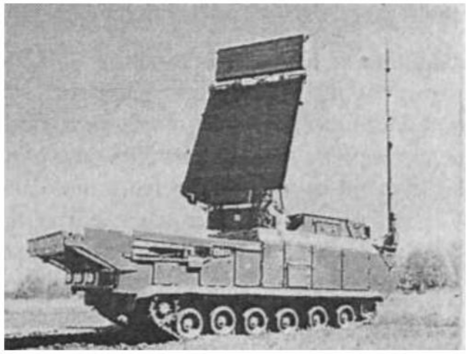
Command post 9S470M1

review period (4.5 s). The root mean square errors (RMS) of measuring target coordinates were: no more than 20' in azimuth and elevation, no more than 130 m in range. Resolution in range is no worse than 300 m, in azimuth and elevation - 4°. To protect against targeted interference, we used tuning of the carrier frequency from pulse to pulse, and from response ones - the same as blanking of intervals

range along the auto-recording channel, from non-synchronous pulse changes in the slope of linear frequency modulation and blanking of range sections. During noise barriers interference from self-cover and external cover at specified levels, the detection and target designation station ensures detection of a fighter aircraft at a range of at least 50 km. The station ensures tracking of targets with a probability of at least 0.5 against the background of local objects and passive interference using a moving target selection circuit with automatic wind speed compensation. The station is protected from anti-radar missiles using a software tuning of the carrier frequency in 1.3 s, switching to a circular

polarization of probing signals or into intermittent radiation (flicker) mode.

The station includes an antenna post consisting of a reflector with a truncated parabolic profile, a feed in the form of a waveguide line that provides electronic scanning of the beam in the elevation plane, a rotating device, a device for folding the antenna into the stowed position, transmitting



Detection and target designation station 9S18M1 (Kupol-M1)

main device (with an average power of up to 3.5 kW), receiving device (with a noise factor of no more than 8) and other systems. All station equipment was located on a modified self-propelled chassis of the SU 1 OOP family. The difference between the tracked base of the detection and target designation station and the chassis of other combat vehicles of the Buk air defense system was determined by the fact that the Kupol radar was initially intended for development outside the air defense system as a means of detecting the divisional air defense unit

of the ground. The time required to transfer the station from traveling to combat position is no more than 5 minutes, and from standby mode to working mode is no more than 20 seconds. The mass of the station with a crew of 3 people is no more

than 28.5 tons. The 9A310 self-propelled firing system in its purpose and design differed from the 9A38 self-propelled firing system of the Kub-M4 (Buk-1) air defense system in that , which, using a telecode line, was interfaced not with the 1S91MZ self-propelled reconnaissance and guidance system and the P25MZ self-propelled launcher, but with the 9S470 KP and the 9A39 launcher-loader. In addition, on the launcher of the 9A310 self-propelled firing system there were not three, but four 9M38 missiles. The time it takes to transfer it from traveling to combat position does not exceed 5 minutes. The time for transferring the installation from standby mode to operating mode, in particular, after changing the position with the equipment turned on, is no more than 20 s. Loading a 9A310 self-propelled firing system with four missiles from a launcher-loading installation was carried out in 12 minutes, and from a transport vehicle in 16 minutes. The mass of a self-propelled firing system with a combat crew of 4 people did not exceed 32.4 tons.

The length of the self-propelled firing system is 9.3 m, width is 3.25 m (9.03 m in working position), height is 3.8 m (7.72 m). The 9A39 launcher-

loading installation located on the GM-577 chassis is designed for transporting and storing eight missiles (4 each on the launcher and on fixed mounts), launching four missiles, self-loading its launcher with four missiles from the cradle, self-loading seven missiles from a transport vehicle (in 26 minutes), from ground supports and from transport containers, loading and unloading a self-propelled firing system with four missiles. Thus, the launch-loading installation of the Buk air defense system

combined the functions of a transport-loading vehicle and a self-propelled launcher of the Kub complex. The starting-charging installation includes, in addition to a starting device with

The power servo drive, crane and cradle included a digital computer, navigation equipment, topographical mapping and orientation, telecode communication, energy supply and power supply units. The mass of the installation with a combat crew of 3 people does not exceed 35.5 tons.

The length of the launcher-loading installation is 9.96 m, width - 3.316 m, height - 3.8 m. The command post

of the complex receives from the command post of the Buk anti-aircraft missile brigade (ASU Polyana-D4) and from the station detection and target designation information about the air situation, processes it and issues target designation to self-propelled firing systems, which, according to the control center, search and capture targets for automatic tracking. When targets enter the affected area, a missile defense system is launched. Missile guidance is carried out using the proportional navigation method, which ensures high targeting accuracy. When approaching the target, the seeker issues a command to the radio fuse for close arming. When approaching a target at a distance of 17 m, the warhead is detonated upon command. If the radio fuse fails to operate, the missile defense system will self-destruct. If the target is not hit, a second missile defense system is launched at it.

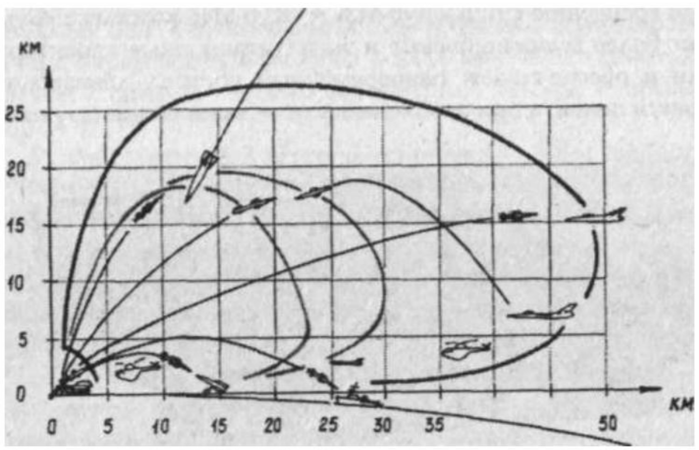
Compared to the Kub-MZ and Kub-M4 air defense systems, the Buk complex has higher combat and operational characteristics and provides: simultaneous firing by a division of up to six targets, and, if necessary, execution of up to six

CP of the anti-aircraft missile *brigade* "Buk" "Polyana-D4"

independent combat missions with the autonomous use of self-propelled firing systems; greater reliability of target detection due to the organization of a joint overview of the space by the detection and target designation station and six-
two self-propelled firing systems; increased noise immunity due to the use of an on-board seeker computer and a special type of illumination signal; greater efficiency in hitting a target due to the increased power of the warhead of the missile defense system.

Based on the results of firing tests and modeling, it was determined that the Buk air defense system provides fire at non-maneuvering targets flying at speeds of up to 800 m/s at altitudes from 25 m to 18 km, at ranges from 3 to 25 km (up to 30 km at target speeds up to 300 m/s) with a heading parameter of up to 18 km with a probability of hitting one missile defense equal to 0.7-0.8. When firing at targets maneuvering with overloads of up to 8g, the probability of defeat was reduced to 0.6.

Organizationally, the Buk air defense systems were consolidated into anti-aircraft missile brigades, which included: CP (combat control point of the brigade from the Polyana-D4 automated control system); four anti-aircraft missile divisions with their own 9S470 command posts, a 9S18 detection and target designation station, a communications platoon and three anti-aircraft missile batteries with two self-propelled fire batteries



Damage zones of the Buk-M1-2 air defense system

9A310 installations and one 9A39 launch-loading installation in each; as well as technical support and maintenance departments. The Buk anti-aircraft missile brigade was to be controlled from the army air defense command post. The Buk complex was adopted by the Air Defense Forces
of the North in 1980. Serial production of the Buk air defense systems was mastered in cooperation involved in the Kub-M4 complex. In 1979, the Buk air defense system was modernized with the aim of increasing its combat
capabilities, its security

radio-electronic means against interference and anti-radar
ny missiles. As a result of tests carried out in 1982, it was found that the modernized Buk-M1 complex, compared to the Buk air defense system, provides a larger kill zone for aircraft, is capable of shooting down ALCM cruise missiles with a probability of hitting one missile system of at least 0, 4, Hugh-Cobra helicopters with a probability of 0.6-0.7, as well as hovering helicopters with a probability of 0.3-0.4 at a range from 3.5 to 6-10 km. The self-propelled firing system uses 72 illumination frequencies (instead of 36), which contributes to increased protection from mutual and intentional interference. Recognition of three classes of targets is provided: aircraft, ballistic missiles, helicopters. The 9S470M1 command post, in comparison with the 9S470 command post, provides simultaneous reception of information from its own detection station

information and target designation and about six targets from the air defense control point of a motorized rifle (tank) division or from the army air defense command post, as well as comprehensive training of all crews of air defense missile systems. The 9A310M1 self-propelled firing system, compared to the 9A310 installation, provides target detection and acquisition for auto tracking at long ranges (25-30%), as well as recognition of aircraft, ballistic missiles and helicopters with a probability of at least 0.6. The complex uses a more advanced detection and target designation station 9S18M1 (“Kupol-M1”), which has a flat angle phased array and a self-propelled tracked chassis GM567M, the same type as the chassis of the KP, self-propelled firing installation and launch-loading installation. Length of the detection and target designation station - 9.59 m, width - 3.25 m, height - 3.25 m

(8.02 m in working position), weight - 35 tons. The Buk-M1 complex provides effective organizational and technical measures for protection against anti-radar missiles. The combat assets of the Buk-M1 complex are interchangeable with the same type of combat assets of the Buk air defense system without modifications; the standard organization of combat formations and technical units is similar to the Buk complex. The technological equipment of the complex includes: 9V95M1E - an automated control and testing mobile station machine on a ZIL-131 and a trailer; 9ÿ883, 9ÿ884, 9ÿ894 - repair and maintenance vehicles for “Ural-43203-1012”; 9V881E - maintenance vehicle "Ural-43203-1012"; 9T229 - transport vehicle for 8 missiles (or six containers with missiles) on the KrAZ-255B; 9T31M - truck crane; MTO-ATG-M1 - maintenance workshop for ZIL-131.

The Buk-M1 complex was adopted by the Air Defense Forces of the Army in 1983. In the same year, the Navy M-22 Uragan air defense system, unified with the Buk air defense system according to the 9M38 missile system, also entered service. Complexes of the Buk family were offered for delivery abroad under the name Gang.

During the Oborona-92 exercise, the Buk family of air defense systems successfully fired at targets based on the R-17, Zvez-da ballistic missiles and on the Smerch MLRS missile.

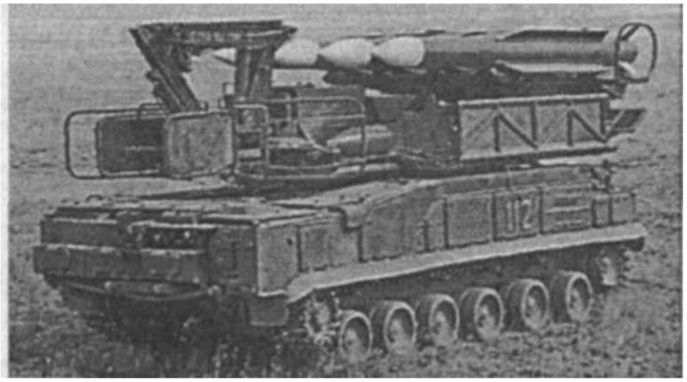
In December 1992, the President of the Russian Federation signed a decree on further modernization of the Buk complex - the creation of an air defense system, which was repeatedly presented at various international exhibitions under the name Ural. Cooperation of enterprises led by NIIP named after. V.V. Tikho-morova in 1994-97. work was carried out to create the Buk-M1-2 air defense system.

Through the use of the new 9M317 missile and the modernization of other means of the complex, for the first time the ability to destroy tactical ballistic missiles of the Lance type and aircraft missiles at ranges of up to 20 km, elements of precision weapons, surface ships at ranges of up to 25 km and ground targets has been ensured (aircraft at airfields, launchers, large command posts) at ranges up to 15 km. Increased efficiency of destruction of aircraft, helicopters and winged

armored missiles. The boundaries of the affected zones have been increased to 45 km in range and up to 25 km in altitude. The new missile provides for the use of an inertial-corrected control system with a semi-active radar seeker with guidance using the proportional navigation method. The launch weight of the rocket was 710-720 kg with a warhead weight of 50-70 kg. The new 9M317 missile differed in appearance from the 9M38 by a significantly shorter wing chord length. In addition to the use of an improved missile, it is planned to introduce into the complex a new radar for illuminating targets and guiding missiles with the antenna placed in the working position at a height of up to 22 m using a telescopic device. With the introduction of target illumination and guidance radars, the combat capabilities of the complex to engage low-flying targets, in particular modern ones, are significantly expanded

cruise missiles.

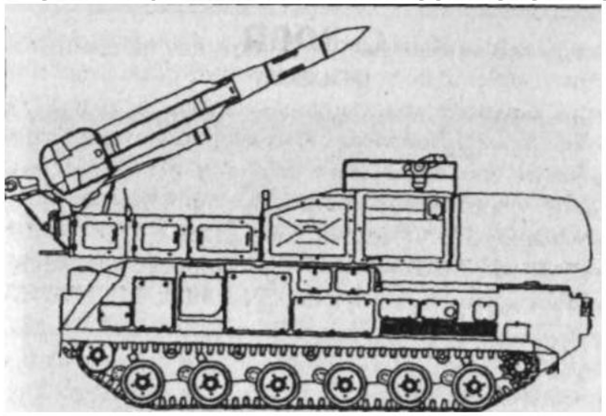
The complex provides for the presence of command posts and firing sections of two types: four sections, each of which includes one advanced self-propelled firing unit, carrying four missiles and capable of simultaneously firing up to four targets, and one launcher-loading unit with eight missiles; two sections, each of which includes one illumination and guidance radar, also capable of providing simultaneous fire at up to four targets, and two launch-loading installations with eight missiles on each.



Loading machine of the Buk air defense system

The complex is being developed in two versions: mobile on tracked vehicles of the GM569 family, similar to those used in previous modifications of the Buk complex, and also transportable on road trains with semi-trailers and KrAZ vehicles. In the latter option, with a slight reduction in cost, the maneuverability indicators deteriorate and the deployment time of the air defense system from the march increases from 5 to 10-15 minutes.

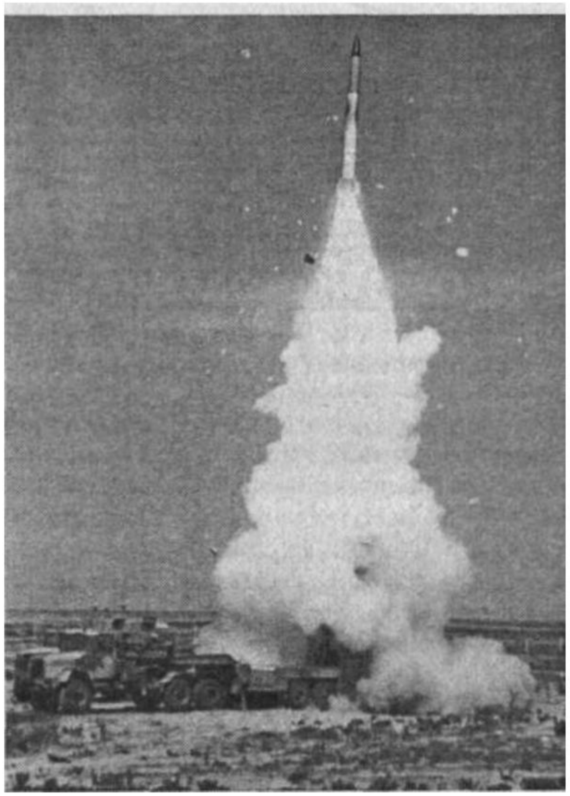
In particular, the Start MKB, while carrying out work on the modernization of the Buk-M complex (Buk-M 1-2 and Buk-M2 air defense systems), developed the 9P619 launcher and the 9A316 launcher-loader on a tracked chassis , as well as a 9A318 launcher on a wheeled chassis. The process of development of the Kub and Buk families of air defense systems is an excellent example of the evolutionary development of weapons and military equipment, ensuring a continuous increase in the combat capabilities of the air defense of ground forces at relatively low costs. Unfortunately, this path of development also creates the preconditions for a gradual technical lag. In particular, even in promising versions of the Buk complex, neither the safest and most reliable scheme for continuous operation of a missile in a transport-launch container, nor the all-aspect vertical launch of missiles introduced in all other second-generation ground forces air defense systems have been used . And yet, in difficult socio-economic conditions, the evolutionary path of weapons development has to be considered as practically the only possible one, and the choice made by the customer and the developers of the Kub and Buk air defense systems as the correct one. The air defense system is in service with Finland, India, Russia, Syria, and Yugoslavia.



TACTICAL AND TECHNICAL CHARACTERISTICS

	"Buk" "Buk-M1" "Buk-M1-2"
Boundaries of the affected area, km: but range	
for aircraft type F-15 for TBR	3.5—25—30 3-32-35 3—45 up to 20 up
type "Lance" for PRR	- to 20
type "Kharm" for KR type	- 20—
ALKM	25 30—35 - 3—25
against surface targets such as destroyer	
in height	
by aircraft type F-15 by TBR	0.015—22 0.015—25 2—
of type "Lance" by PRR	. 16 . 0,
of type "Kharm" but the	1—15 to 18
parameter	to 22
Probability of defeat:	
fighter one SAM helicopter	0.8—0.9 0.8—0.95 0.9—0.95 0.3—
one SAM cruise missile	0.6 0.3—0.6 0.25—0.5
Maximum speed of	0.4—o!b 0.5 —0.7
targets hit, m/s Reaction	
time, s Flight speed of SAM,	800 800
m/s Weight, kg:	22 22
Missile warhead, kg Channel to	850 850
target	
Channel	685 685 710-720 70
to missile (per	70 70 2 2 to 3 to 3
target) up to 3 Deployment	5 5 1980 1983
time (collapse), min 5 Year of adoption	

s-zoop



At the end of the 60s, a new long-range anti-aircraft missile system was created in the Soviet Union, and three types of complexes were simultaneously designed. The Almaz design bureau developed the S-ZOOP air defense system mounted on a wheeled chassis for the country's air defense forces. The S-300F air defense system was developed at the Altair Research Institute for the Navy and Ground Forces. The S-300V complex, which was supposed to be installed on a tracked chassis, was developed at the Research Institute-20 of the Ministry of Radio Industry (later renamed the Antey Design Bureau). In accordance with the tactical and technical specifications, initially only the S-300V air defense system was supposed to have

capabilities to destroy tactical ballistic missiles. Large-scale unification of

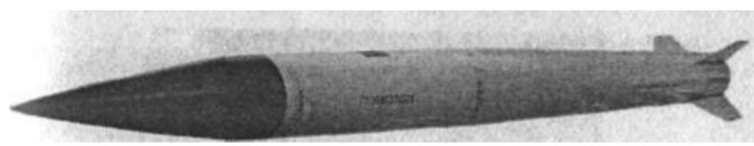
elements of all three types of air defense systems was envisaged. For example, to provide anti-aircraft defense against targets flying at speeds of up to 3,500 km/h at altitudes from 25 to 25,000 m, at ranges from 6 to 75 km, it was planned to use the V-500R missile developed by the Fakel IKB with a combined guidance system . And at the first stage, a simplified and much cheaper V-500K missile with a radio command guidance system was created for use at ranges of up to 50 km. But it was not possible to achieve deep interspecific unification of the S-300 air defense systems, since the elements of the complexes

were developed by various industrial enterprises and used

who called their components and their technologies. In the process of creating the S-ZOOV system, the developers abandoned the use of the Fakel design bureau's missile defense system, preferring for anti-aircraft defense the missile created at the Sverdlovsk Novator design bureau. The

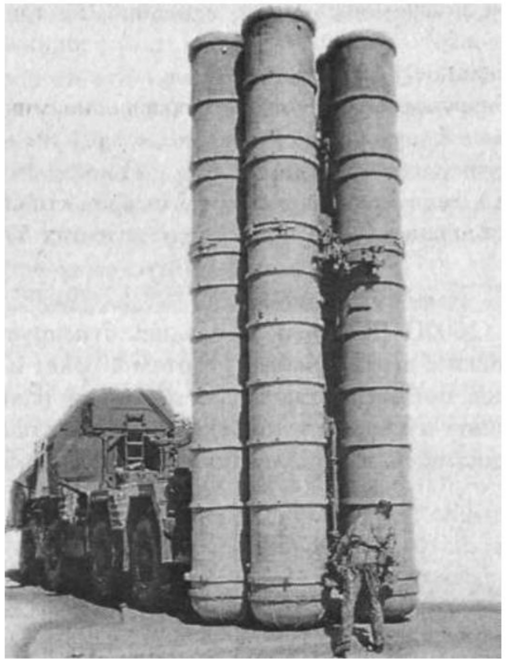
S-300P air defense system (P - mobile) was put into service in 1979. It replaced the S-25 Berkut air defense systems located around Moscow, as well as the S-125 and S-75 complexes. It is believed that the first regiment of the S-ZOP, which carried out combat duty in 1979, was the regiment stationed in the city of Elektrostal, Moscow region. According to Jane magazine estimates, at the end of 1996, 2,075 launchers for the S-300 family of complexes were produced.

The S-ZOOP (PT) air defense system used towed launchers with vertical launch of 4 missiles and transport vehicles designed to transport missiles. At the launch position, the launchers extended outrigger supports to achieve stabilization and leveling. Time



General view of the 5V55 rocket

The time it took to bring the complex's launch equipment into combat readiness at a new launch position exceeded 30 minutes. As stated earlier, the S-300PT complex initially used the original V-500K missile, which was the first Soviet missile to include a significant level of electronics in its control system. The maximum effective range for hitting an aerodynamic target was 47 km. The rocket has a solid propellant engine; upon launch, it was ejected from the transport and launch container using squibs to a height of 25 m, and then the rocket engine was started. One of the authors, while serving in the 234th training center for the combat use of anti-aircraft missile forces (Priozersk, Kazakhstan) in the mid-80s, witnessed the destruction of a target missile by a B-500K missile at a distance of significantly greater than 47 km. This fact did not become widely known, since then the score for the result of combat shooting would have to be reduced.



Launcher

of an anti-aircraft missile regiment from “excellent” to “good” due to firing at a target located outside the launch zone. The S-300PT complex includes:

• illumination and guidance radar (RPN) ZONb, which guides up to 12 missiles to 6 simultaneously tracked targets in an azimuth sector of 60° (later 120°);

• low-altitude detector (LDA) - a radar for reconnaissance of low-altitude targets, which has a continuous signal, is usually located on a 24-meter tower in order to increase the detection range of suddenly appearing targets on low altitudes;

• up to 3 launch complexes, each of which can have up to 4 launchers, and each launcher can have up to 4 missiles of the V-500K or V-500R type located in the TPK (thus, the maximum number of missiles in the set there are 48 pieces);

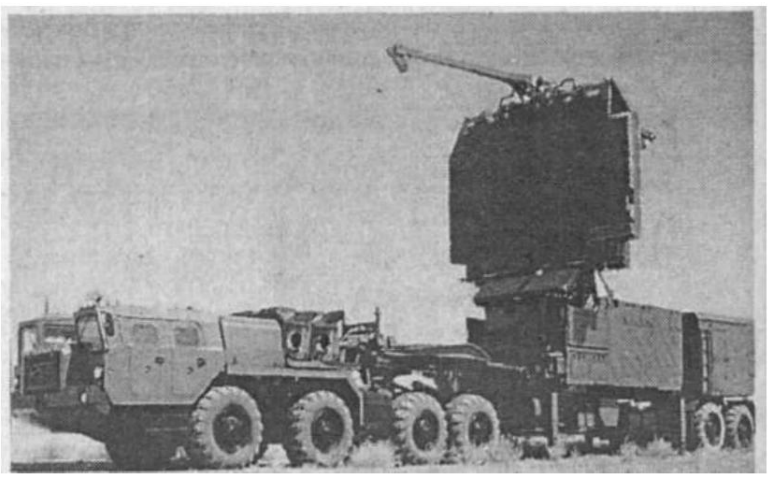
• means of autonomous power supply, cabins with located spare property and accessories contained in them, cable management. NVO detects a low-altitude aerodynamic target

with effective reflective surface 1 m^2, flying to at an altitude of 100 m, at ranges of up to 45 km, and subsequently at 50 km. Cruise missile type targets with an effective dispersion surface of 0.1 m^2, flying at altitudes of 50 m, detected

Illumination and guidance radar (RPN) 30N6, in the background - low-altitude detector (LAD)

live at ranges of up to 28 km, and subsequently - from 38 km, which allows the combat crew of the complex to confidently destroy targets both in the depths of the affected area and on the near border of the affected area. The probability of hitting a target with one missile was 0.7.

The S-300P air defense system was in service with anti-aircraft missile regiments and brigades of the country's air defense forces. In addition to the S-ZOOP air defense system, the regiment included a command post 5N83 as part of a combat control point (LCU) 5K56 and a detection radar (RAO) 5N64K. The combat operations of a regiment (brigade) were controlled centrally with the help of a command post. Detection and state identification of air targets is carried out by radar at ranges of up to 300 km, information about all detected targets is transmitted to the combat control point, where target routes are formed, target distribution and target designation is issued to combat-ready systems (taking into account the available number of missiles). The commander of the PBU combat crew could interfere with the automated mode of issuing target instructions and, through his decision, carry out manual target distribution. Information about newly discovered low-flying targets (with the help of NVO) was also displayed on the indicators of the PBU combat crew. The combat crew controlled the technical



Detection radar (SAR) 5N64K

ical condition of all PBU systems, SAM and SAM systems. The high level of standardization of the combat work of all systems, modern (at that level) combat work algorithms ensured the high efficiency of the combat work of each S-ZOP air defense system (simultaneous shelling of up to six targets and guidance of 12 missiles).

In 1982, in addition to the S-ZOP complex, self-propelled complex S-ZOOPS into service.

After the end of the Gulf War, the S-ZOP air defense system was tested as a means of combating tactical ballistic missiles. The elements of the complex have been improved, and the combat control algorithms have been improved. It is believed that the complex significantly surpassed the American Patriot air defense system in its tactical and technical characteristics. The export version of the first-generation air defense system S-ZOOP received the designation S-ZOPMU, and the modification of the 1993 new release S-300PM became known as S-ZOPMU 1. It was this complex that was demonstrated at the international arms exhibition "IDEX-93", and subsequently purchased by the Cypriots in January 1997. There is information about the sale of the S-300PMU1 complex to China. The S-ZOPMU 1 air defense missile system is available in self-propelled and towed (cheaper) versions. These second-generation air defense systems differ from the systems of previous modifications primarily due to the use of the 48N6 missile, which has a firing range of up to 150 km.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km: maximum with	
the V-500K missile, maximum with the	47.0
V-500R missile, minimum	75.0
	5.0
Damage height, km:	
maximum	25.0
minimum	0.025
Probability of hitting targets: aerodynamic	
ballistic	0.7—0.9
	0.4—0.7
cruise missiles	0.4—0.8
Channel to target Channel	up
to missile Collapse time, h	to 6 2 for each goal
	3.0

S-300PMU1, S-300PMU2 "Favorite"

(RUSSIA)

The S-300PMU1 anti-aircraft missile system is designed for effective air defense against air strikes, cruise and aeroballistic missiles in difficult air conditions and when the enemy uses strong radio countermeasures. During 1980-1990 The S-300 anti-aircraft missile system has undergone a number of deep modernizations,

which significantly increased its combat capabilities.

In the mid-80s, the S-300PMU air defense system was adopted. And in 1993, its modernization was successfully completed, aimed at further increasing the automation of combat operations, the ability to destroy modern ballistic missiles with flight speeds of up to 2800 m/s, increasing the range of radar stations, replacing the element base and electronic -computer. There has been a noticeable improvement in computer software and missiles, and the introduction of a longer-range anti-aircraft missile into the system, which means

significantly increased the affected area and possible coverage area. As a result, the system, designated S-300PMU1, doubled its combat potential.

The 83M6E control equipment is designed for information support and control of S-300PMU1 air defense systems.

83M6E controls include:
• combat control point (PBU) 54K6E; • detection radar (SLR) 64N6E; • means of external (SVEP) power supply for RLO and PBU as part of RPU and cable sets; • topographic surveyor 1T12-2M; • spare parts kits in semi-trailers.

Additional means can be attached to the 83M6E control equipment, namely, YuT24TsV towers, a 13YU6E digital computer complex repair laboratory, a 15YA6E repeater, and diesel power plants.

The S-300PMU1 air defense system includes:

1. Anti-aircraft missile system (SAM) 90ZH6E1, which includes:

a) illumination and guidance radar (RPN) 30N6E1; b) 12 launchers (PU) 5P85TE and (or) 5P85SE with four missiles in TPK on each;
c) topographic surveyor 1T12-2M; d) means of external power supply for on-load tap-changers, control units consisting of distribution and converting devices (DCU) and cable sets;
e) means of technical operation and storage of missiles (charging machine 22T6E, transport vehicle 5T58E); f) spare parts kits in trailers; g) trailer with operational documentation PED-2E. 2. Combat set of anti-aircraft guided missiles 48N6E. 3. Additional equipment S-300PMU1: • low-altitude detector (HBO) 76H6; • tower 40V6M for on-load tap-changer 30N6E1 with a set of cables; • repair laboratory of pulp and paper mill 13YU6E; • diesel power plants; • ZIP-2 group kits in semi-trailers.

The S-300PMU1 and SU 83M6E air defense systems provide high efficiency in hitting air targets, a high degree of automation of the processes of detecting and capturing targets for tracking, simultaneous firing of up to six targets with guidance.

they carry up to 12 missiles and high mobility, the ability to conduct autonomous combat operations, as well as the operation of missiles without maintenance for 10 years and the possibility of integration into any air defense groupings.

There is information in the public press about the sale of the S-300PMU1 air defense system by the Russian Federation to foreign countries, in particular to China and Greece.

TACTICAL AND TECHNICAL CHARACTERISTICS of the S-300PMU1 air defense system

Range of destruction of aerodynamic targets, km:	
maximum	150.0
minimum	5.0
Damage height, km:	
maximum	27.0
minimum	0.01
Maximum heading parameter, km Ballistic missile engagement range, km:	±148
maximum	40.0
Damage height, km:	
maximum	25.0
minimum	2.0

Maximum heading parameter, km ±20 Number of simultaneously fired targets up to 6 Number of simultaneously aimed missiles up to 12 Maximum speed of targets hit, m/s up to 2800 8—10* Reaction time, s Deployment/collapse time, min 5 Number of missiles per launcher, pcs. 4
Weight of the missile warhead, kg 143

* _ during target designation from the 83M6E control system.

TACTICAL AND TECHNICAL CHARACTERISTICS
OF THE 83M6E CONTROL SYSTEM

Number of simultaneously detected targets up to 300 Number of simultaneously tracked target tracks up to

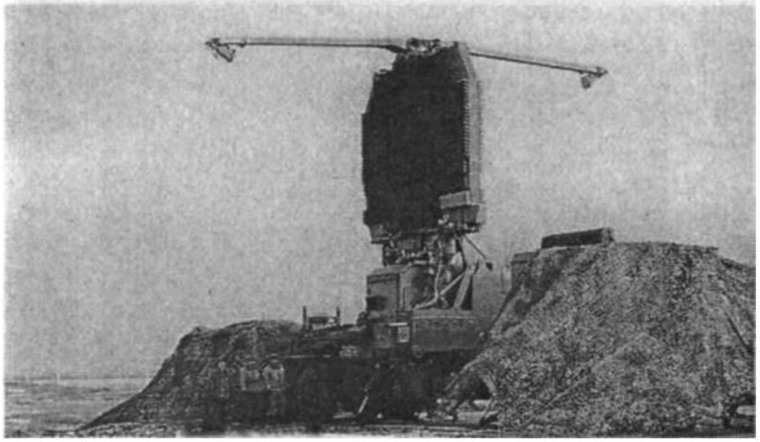
Parameters of the radar detection zone (azimuth angle of elevation), deg.:	100
aerodynamic targets ballistic targets	360x14 60x75
Target designation range for targets, km: aerodynamic ballistic Number of simultaneously	D° 280 To 140
issued target indications	UP TO
Deployment/collapse time, min	36 5

In 1995-1997 The Russian Federation carried out another modernization of the S-300PMU1 air defense system and created the S-300PMU2

(“Favorit”) air defense system. Combat capabilities have increased due to the creation of a new 48N6E2 missile, which has an increased efficiency in hitting ballistic targets, ensuring detonation of the target's warhead, increasing the far boundary of the aerodynamic target destruction zone to 200 km, including when firing after, expanding information capabilities - the command post of the SU 83M6E2 for the detection and tracking of ballistic targets while maintaining the sector for detecting aerodynamic targets.

In addition, the detection characteristics of the system during autonomous combat operations have been increased due to the use of the new autonomous target designation system PAC 96L6E, it is possible, along with 48N6E2 missiles, to use S-300PMU1 48N6E air defense missiles, and it is possible to integrate the Favorit system into any air defense systems , including in the air defense systems of NATO countries. The air defense system includes a command post for the 83M6E2 control system

and up to six S-300PMU2 (90Zh6E2) anti-aircraft missile systems.



Detection radar 64N6E

The command post includes a 54K6E2 combat control post and a 64N6E2 detection radar. Have-
All means of interfacing with a higher command post. Each air defense system includes a multifunctional illumination and guidance radar (RPN) 30N6E2 and up to 12 launchers (PU) of the 5P85SE, 5P85TE type. The air defense system can be equipped with an all-altitude detector (VVO) 96L6E.

The 64N6E2 surveillance radar of the command post of the 83M6E2 control system with an S-band phased array antenna provides detection of air objects within a radius of 300 km and determination of the state affiliation of an air object using recognition systems. Information about targets is transmitted via communication lines to the combat control point, which summarizes and processes all

Multifunctional illumination and guidance radar 30N6E2

information about the air situation from various sources and displays it on its indicators when working with
the higher command post receives control commands and information about air objects from it. The PBU carries out the establishment of routes of detected targets, assesses the degree of their danger and makes target distribution to combat-ready air defense systems by issuing target designations for targets. All work of the combat control point can be carried out fully automatically. The PBU is capable of controlling air defense systems of various types, in particular the S-300PMU2, S-300PMU1, S-300PMU, S-200VE air defense systems in any combination. With the help of special equipment, documentation of combat operations is carried out for the purpose of subsequent

analysis.

Illumination and guidance radar 30N6E2 SAM 90Zh6E2 based on information received from the PBU and all-altitude

Low-altitude detector 76N6

detector, provides search, detection, automatic tracking of targets, carries out all operations related to the preparation and firing of anti-aircraft missiles, and also evaluates the results of firing. The versatility of the radar (tracking targets and missiles aimed at them) is ensured by the use of X-band phased array antennas and high automation of all processes of its functioning based on modern computer systems with high-speed control algorithms.

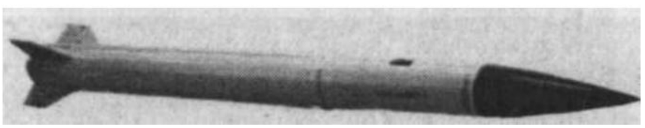
The 5P85SE (5P85TE) vertical launch launcher provides storage, transportation and launch of missiles. Vertical launch allows you to fire at targets flying from any direction. The launcher contains four 48N6E2 (48N6E) missiles. Having the missile in a sealed transport and launch container (TPC) allows it to avoid maintenance for ten

years of operation.

A special feature of the Favorit air defense system is its 48N6E2 missile, which has high maneuverability and overload capabilities. The missile is equipped with a high-explosive fragmentation warhead and ensures the destruction of air targets at ranges from 3 to 200 km, both on a collision course and when firing in pursuit. When a missile warhead is detonated by optimizing the area of dispersion of fragments and

Their spatial-energy characteristics initiate the warhead of a ballistic missile in the air, thereby significantly reducing possible damage.

The new 96L6E all-altitude target designation radar with a multi-beam phased array antenna automatically provides the 30N6E2 RPN and the 83M6E2 command post with information about the air situation for all air traffic



General view of the 48N6 rocket

targets flying from any direction. Through the adaptive use of wide-baseline signals and multi-frequency operation, the all-altitude locator provides effective detection of both the most dangerous low-altitude targets and targets at medium and high altitudes. Typically, the antenna device of an all-altitude radar is raised on a special tower, thereby achieving detection of targets at extremely low altitudes in forest and very rough terrain.

TACTICAL AND TECHNICAL CHARACTERISTICS of the S-300PMU2 air defense system

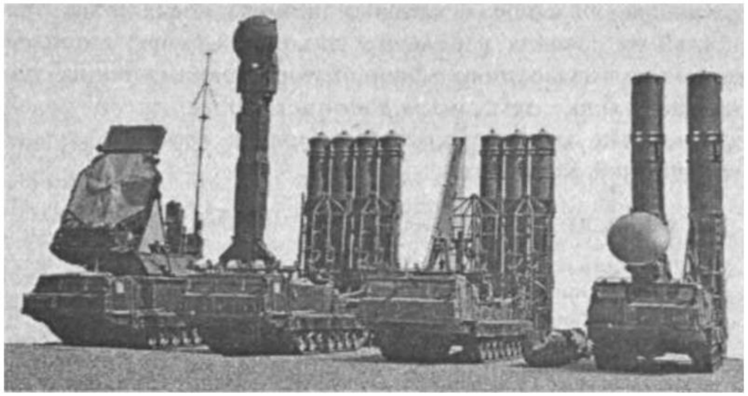
Range of destruction of aerodynamic targets, km:	
maximum	200.0
minimum	3.0
Damage height, km:	
maximum	27.0
minimum Maximum	0.01
heading parameter, km Ballistic missile engagement	±195
range, km:	
maximum	40.0
Damage height, km:	
maximum	25.0
minimum	2.0

Maximum heading parameter, km ±(25-35) Number of simultaneously fired targets up to 6 Number of simultaneously aimed missiles up to 12 Maximum speed of targets hit, m/s up to 2800 Reaction time, s 8-10 Deployment/collapse time , min 5 Number of missiles per launcher, pcs. 4 Mass of the missile warhead, kg 180 Probability of hitting one missile: aerodynamic targets ballistic missiles Speed of movement of combat vehicles, km/h:

0.8—0.95
0.8—0.97

along the highway	60.0
on dirt roads	30.0

S-ZOOV
(RUSSIA)



The S-ZOOV air defense system is a front-line air defense system designed to destroy ground-based (Lance, Pershing) and air-based (SRAM) ballistic missiles, cruise missiles, strategic and tactical aircraft, loitering active jammers, combat helicopters,

years under conditions of massive use of these air attack weapons, as well as in difficult air and interference situations and when covered troops are conducting maneuverable combat operations. At the end of the 70s, the deployment of American Pershing-2 ballistic missiles began in Europe, the maximum range of

which was estimated at 2500 km. In this regard, a significant expansion of the combat capabilities of domestic anti-aircraft missile systems was required.

The S-ZOOV military self-propelled anti-aircraft missile system was developed in accordance with the general tactical and technical requirements for the S-300 system, specific requirements for the S-ZOOV system and for the Obzor-3 radar, used as an all-round radar in this system . The S-ZOOV anti-aircraft missile system, complete with all its equipment, was adopted by the air defense

of the ground forces in 1988.

All combat assets of the system were placed on unified tracked chassis with high cross-country ability and maneuverability, equipped with navigation, topographical reference and relative orientation equipment, which were also used for the Pion self-propelled artillery mount and unified in individual units with the tank. com T-80.

The 9S457 command post is designed to control the combat operations of anti-aircraft missile divisions of the S-ZOOV system, both during autonomous operation of the system and when controlled from a higher command post of an anti-aircraft missile brigade in anti-missile and anti-aircraft defense modes.

In the missile defense mode, the command post ensured the operation of the air defense system to repel the attack of Pershing-type ballistic missiles and aircraft missiles detected using the "Ginger" program survey radar and aircraft missiles, received radar information, controlled the combat operating modes of the "Ginger" radar and the multi-channel station missile guidance, recognition and selection of true targets based on trajectory characteristics, automatic distribution of targets among air defense systems, as well as issuing sectors of operation of the “Ginger” radar for detecting ballistic and aero-ballistic targets, jamming directions for determining the coordinates of jammers. The KP took measures to maximize automation of the management process. In the anti-aircraft defense mode, the command post ensured the operation of up to four air defense systems (6 target channels in each) to reflect the attack of aerodynamic targets detected by the Obzor-3 all-round radar (up to 200), including

conditions of interference, carried out the initiation and maintenance of routes targets (up to 70), receiving information about targets from a multi-channel missile guidance station and a higher command post, recognizing classes of targets (aerodynamic or ballistic), selecting the most dangerous targets to engage air defense systems.

The command post provided for the issuance of up to 24 target designations (TC) of the air defense system during the target distribution cycle (3 s). The average operating time of the command post from receiving marks from targets to issuing the control center when working with an all-round radar (with a review period of 6 s) was

17 p. When working on the Lance-type ballistic missile, the control point issuance limits were 80-90 km. The average operating time of the control panel in the missile defense mode did not exceed 3 s. All the command post equipment, which included special computers, equipment for telecode and voice communication lines with mating objects, an air defense missile system control station with three workstations, equipment for documenting the operation of the command post and combat equipment of the system, navigation equipment, topographical reference and orientation, an autonomous power supply system (gas turbine power unit), life support equipment, was placed on the "object 834" tracked chassis. Weight of the command post - 39 tons. Crew - 7 people

catcher

The 9S15M all-round radar "Obzor-3" is a three-coordinate coherent-pulse radar detecting the centimeter wave range with instantaneous frequency tuning, programmable electronic beam control (1.5°x1.5°) in the elevation plane, electrohydraulics - technical rotation of the antenna in azimuth and high throughput.

The radar implemented two modes of circular regular review of the airspace, used in detecting aerodynamic targets, as well as ballistic missiles of the Scud and Lance types. In the first mode, the station's viewing area was 45° in elevation, the instrumental detection range was 330 km, and the viewing rate was 12 s. The fighter was detected with a probability of 0.5 at a range of 240 km.

In the second mode, the station's viewing area was 20° in elevation, the instrumental range was 150 km, and the viewing rate was 6 seconds. In this mode, to detect ballistic missiles, a program was provided to slow down the rotation of the antenna in azimuth in the missile defense sector (within 120°) and increase the viewing sector in elevation to 55°. At the same time, the rate of information update was 9 s. The fighter aircraft was reliably detected within the entire instrumental range, and the Scud-type ballistic missile was detected at a range of no less than 115 km.

The all-round radar provided output in the mode

automatic data collection of up to 250 marks during the review period, among which there could be up to 200 targets. All devices and various equipment of the all-round radar were mounted on the "object 832" tracked chassis. Station weight - 46 tons. Crew - 4 people.

The program review radar 9S19M2 "Ginger" is a three-coordinate coherent-pulse radar of a sanitary

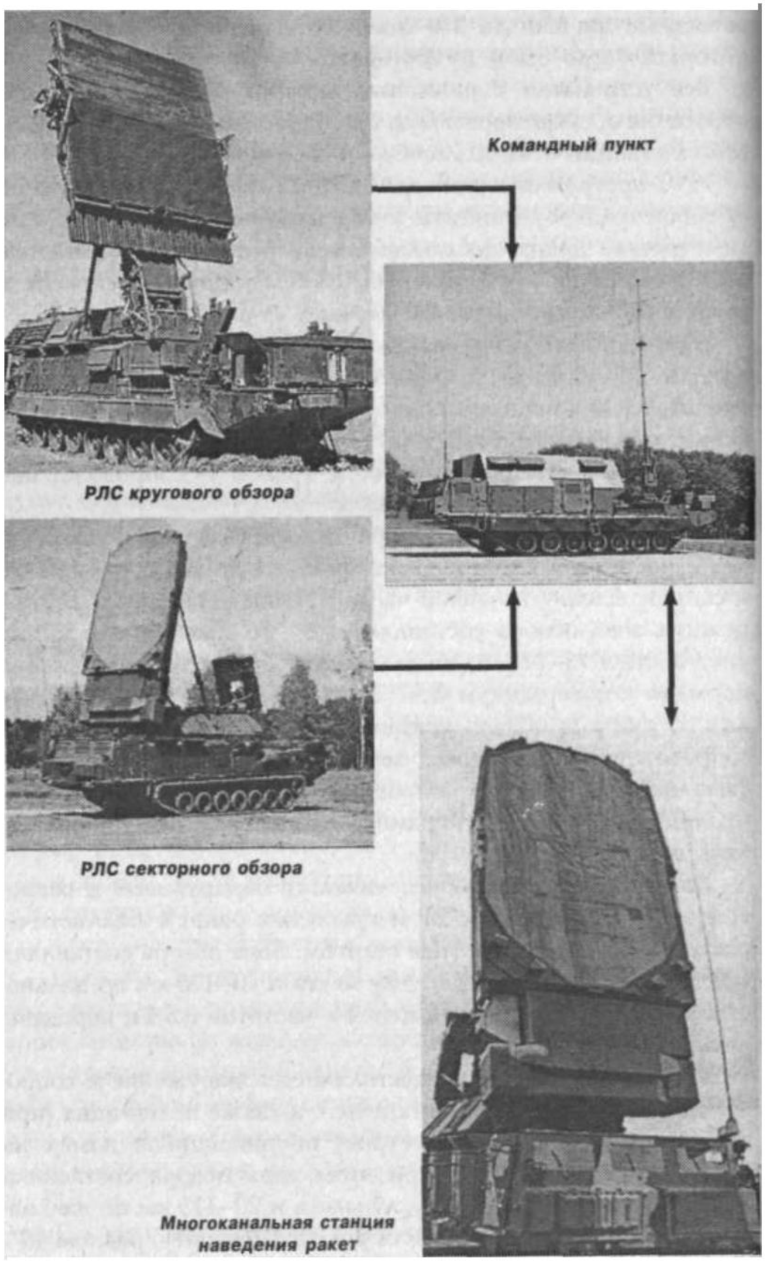
time range with high energy potential

crowbar, electronic beam control in two planes and high throughput. Electronic scanning of the beam in two planes made it possible, in the process of regular review, to quickly provide analysis of target designation sectors from the CP system or cyclic high-speed (1-2 s) access to detected marks in order to link them into routes and track routes of high-speed targets. The software survey radar implemented several survey modes. One of the modes provided detection and tracking of the warhead of the Pershing-type ballistic missile. In this mode, the viewing area was ±45° in azimuth, 26–75° in elevation, and 75–175 km in range. In this case, the angle of inclination of the normal to the surface of the phased array relative to the horizon was 35°. The review time for the specified search sector, taking into account the tracking of two target tracks, was 12.5-14 s. The maximum number of assisted routes is 16.

Every now and then the coordinates and parameters of the target's movement were transmitted to the system's control panel.

The second mode provided detection and tracking of aircraft ballistic missiles and cruise missiles with ballistic and aeroballistic launch. The viewing area was •30° in azimuth, 9–50° in elevation, and 20–175 km in range . Parameters of target movement with a frequency of 0.5 Hz were transmitted to the 9S457 CP.

In the third mode, detection and tracking of aerodynamic targets was carried out, as well as direction finding (and, if possible, ranging) of jammers at distances of up to 100 km. In this case, the viewing area was • 30° in azimuth, 0–50° in elevation, and 20–175 km in range at an angle of inclination of the phased array normal to the horizon equal to 15°.



The viewing direction was set via a telecode communication line with the system control panel or the station operator. During a regular review of the area, target designation received from the system's command post automatically interrupted the review, and after the control center had been worked out, the review was resumed. The rate of information update depended on the size of the established search area, as well as on the interference situation, and could vary from 0.3 to 16 s. The coordinates of detected targets were transmitted to the command post. The root mean square errors in measuring target coordinates did not exceed 70 m in range, 15'

in azimuth, 12' in elevation. The radar equipment was placed on a self-propelled tracked "object 832". Station weight - 44 tons. Crew - 4

people. The multi-channel missile guidance station was capable of simultaneously performing a sector search for targets (based on control center data or autonomously) and tracking up to 12 targets, simultaneously controlling the operation of all launchers and launch-loading installations of air defense systems, transmitting to them the information necessary for launch and guidance 12 missiles for six targets. The station simultaneously regularly monitored the ground edge, where low-flying targets could appear.

The station is a three-coordinate multi-channel coherent-pulse radar for targets and missiles.

time range with high energy potential

scrap, electronic scanning of the beam in two planes,

ensured through the use of a phased antenna array and a beam control system based on a special computer in the station.

The multi-channel missile guidance station, when operating in the control mode, provided detection of fighters at altitudes of more than 5 km at ranges of 150 km, Scud-type ballistic missiles - 90 km, Lance - 60 km, the head of a Pershing missile - 140 km, aircraft rockets - 80 km. From the moment of discovery

until the transition to automatic target tracking from one

a significant determination of the parameters of its movement passed from 5 s ("Pershing") to 11 s (the target is a fighter). When working in autonomous mode, the multi-channel missile guidance station provided detection of fighter aircraft at ranges of up to 140 km.

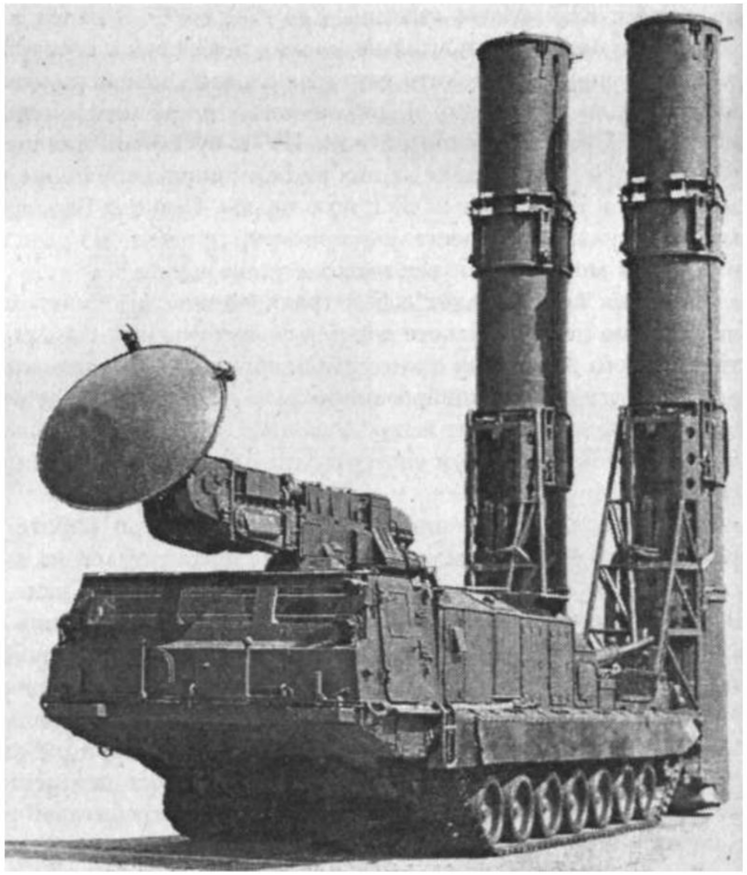
All station equipment was mounted on tracked

chassis number "object 833". Station weight - 44 tons. Calculation - 6 people
catcher

The 9A83 launcher is capable of providing simultaneous pre-launch preparation and launch of two missiles with inter- shaft 1-2 s. The time for pre-launch preparation of missiles is no more than 15 s.

Loading the PU 9A83 was carried out using a launcher charging installation 9A85.

During preliminary cable pairing, the switching time of the launcher equipment from its own ammunition is



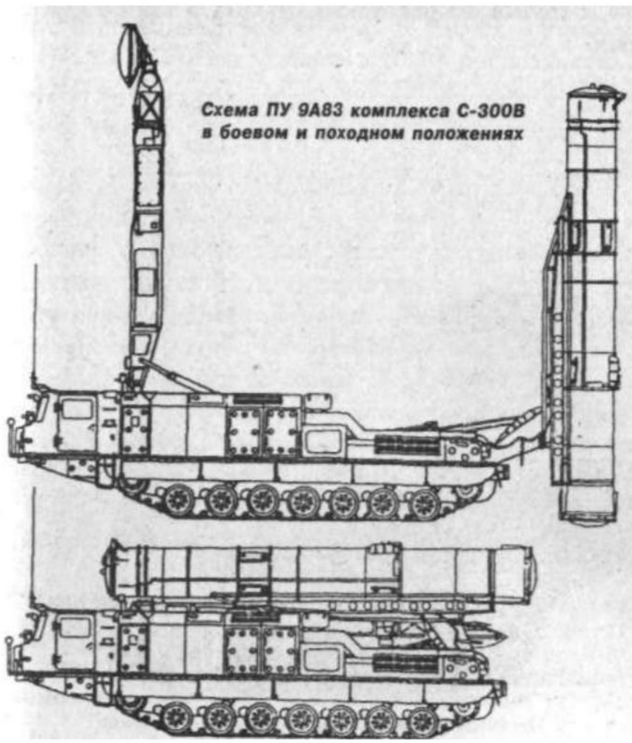
Launcher *9A82*

The missile loading time for the launch-loading installation did not exceed 15 s. Based on the commands and

control center transmitted via a telecode radio link from the multi-channel missile guidance station, the launcher ensured the preparation of missiles, the testing of the control center of the target illumination station antenna system mounted on it, the generation and display on the launch indicator of information about the time before the target enters the affected area and time before it leaves the zone, transferring the solution to this problem to a multi-channel missile guidance station, launching two missiles, as well as analyzing the presence of interference on the missile seeker and transmitting its results

to a multi-channel missile guidance station.

After the launch of the missile defense system, the launcher provided information on the number of missile defense systems launched from it and from the associated missile guidance station to the multi-channel missile guidance station.



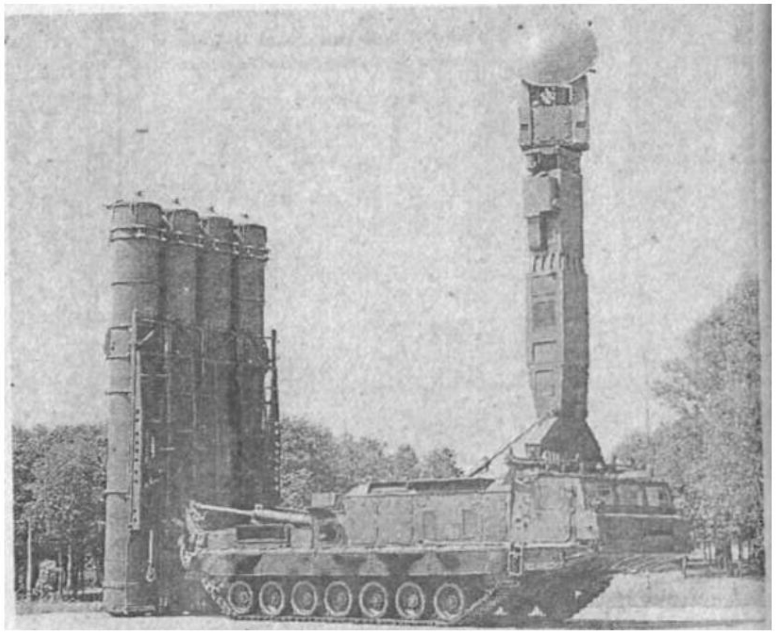
with it the launcher-loading installation, turning on the antenna and transmitting systems of the target illumination station for radiation in the mode of transmitting commands for radio correction of the missile defense flight, as well as its switching to radiation in the target illumination mode. 1

All of the specified launcher equipment was located on the tracked I chassis "object 830". The total weight of the launcher with missile defense ammunition is - 47.5 tons. PU calculation - 3 people.

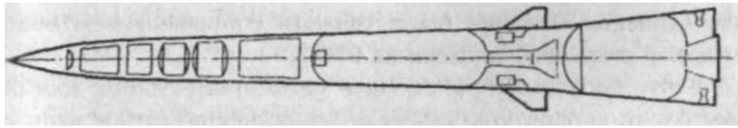
The 9A82 launcher was intended for trans-! porting and storing fully combat-ready two 9M82 missiles in the TPK, as well as for performing the same operations that the 9A83 launcher performs.

The 9A85 launcher is designed for transporting and storing four 9M83 missiles in a TPK, launching 9M83 missiles together with the 9A83 launcher equipment, loading the 9A83 launcher with missiles (from itself, from a 9T83 transport vehicle or from national economic vehicles, from the ground , from the MS-160.01 package), as well as for self-

mumbling.



Launcher 9A83 in firing position



Layout of the 9MS3 missile of the S-ZOOV complex

Loading time of PU 9A83 with full ammunition of missiles was 50-60 minutes, the crane’s lifting capacity was 6350 kg.

The composition of the launch-loading installation differed from the launcher in the presence of a crane installed instead of various radio-electronic equipment and a target illumination station. There were cables on it that connected the missiles placed on it with the PU 9A93 equipment. Instead of a gas turbine power supply unit, a diesel unit was used at the starting-charging installation.

All equipment and ammunition for the missile defense system were located on the “object 835” tracked chassis. The mass of the launch-loading installation with missile defense ammunition is 47 tons. Crew is 3 people.

The 9A84 launch-loading installation was intended for transporting and storing two 9M82 missiles in transport and launch containers, launching a 9M82 missile defense system together with the 9A82 launcher equipment, loading this launcher and self-loading. In terms of its design, it differed from the 9A85 installation only in the design of the device for installing the TPK into the starting position, and in terms of basic characteristics and principles of operation was similar to it.

The 9M83 anti-aircraft guided missile is designed to destroy aircraft (including those maneuvering with overloads of up to 7-8 g and in conditions of radio countermeasures), cruise missiles, including low-flying ones, and ballistic missiles of the Scud and Lance type, and missile defense systems 9M82 - to destroy the warheads of Pershing-1A, Pershing-1B missiles, SRAM-type aircraft missiles, and active jamming aircraft at ranges of up to 100 km.

The 9M82 and 9M83 missiles were two-stage solid-fuel missiles, made according to the “carrying cone” aerodynamic design with first-stage gas-dynamic controls. The missiles were placed in the TPK. The design of the missiles was unified to the maximum extent possible.

However, the main differences were associated with the use of a more powerful starting stage on the 9M82.

In the head part of the missiles, units of homing equipment common to missiles, a non-contact explosive device (NVD), an inertial control system, and an on-board computing device were placed. The missiles are equipped with a directional warhead. Four aerodynamic rudders and four stabilizers were located on the tail section of the sustainer stage.

In the mode of centralized control of the S-300V air defense system, it worked according to commands, target distribution and target designation from the command post (Polyana-D4 automated control system) of the anti-aircraft missile brigade, into which anti-aircraft missile divisions armed with the S-ZOOV complex were organized organizationally. The brigade was supposed to have an automated command post (combat control point) from the specified automated control system with a radar post (which included the 9S15M all-round radar, the 9S19M2 program review radar, the 1L13 standby radar and the PORI-P1 radar information processing station),

three or four anti-aircraft missile divisions.

Each anti-aircraft missile division consisted of a 9S457 command post, a 9S15M radar, a 9S19M2 radar and four anti-aircraft missile batteries, each of which included one 9S32 multi-channel missile guidance station, two 9A82 launchers, one 9A84 launcher-loader, four 9A83 launchers and two launchers. charging installations 9A85.

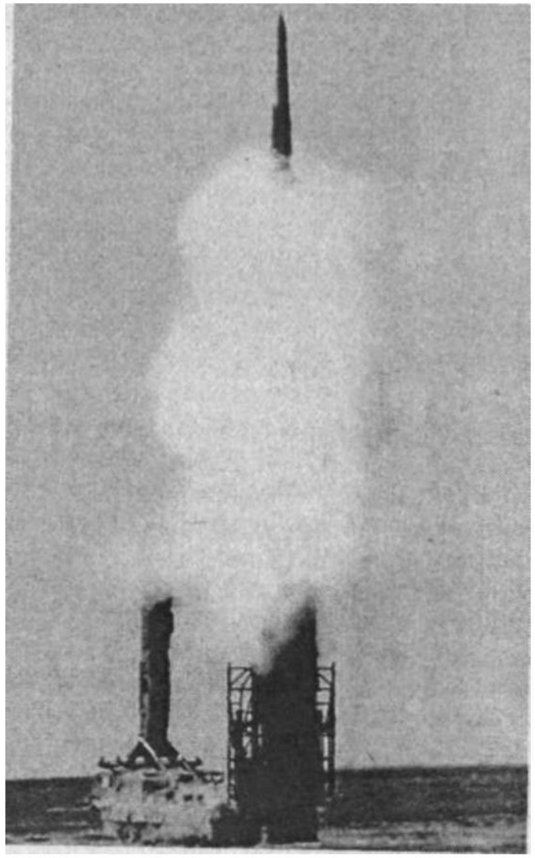
Front-line anti-aircraft missile brigades S-ZOOV were supposed to replace army-front anti-aircraft missile brigades with the Krug complex.

High combat capabilities and mobility of anti-aircraft S-ZOOV missile systems have been repeatedly confirmed by live training and special exercises.

The creation of the S-ZOOV air defense system was a significant domestic a significant scientific and technical achievement that is ahead of foreign plans.

The Antey-2500 anti-aircraft missile system, developed in recent years, provides the ability to intercept ballistic missiles with a range of up to 2500 km, the maximum range for hitting aerodynamic targets has been increased to

200 km. The Antey-2500 system includes the 9S457M command post, 9S15M2 all-round radar, 9S19M program-view radar, 9S32M multi-channel missile guidance stations, 9A83M, 9M83M and 9M82M missile launchers. The system is capable of simultaneously firing at 24 aerodynamic targets or 16 ballistic missiles with an ESR of 0.02 m^2, flying at speeds up to 4500 m/s.



Rocket launch from the Antey-2500 complex

TACTICAL AND TECHNICAL CHARACTERISTICS

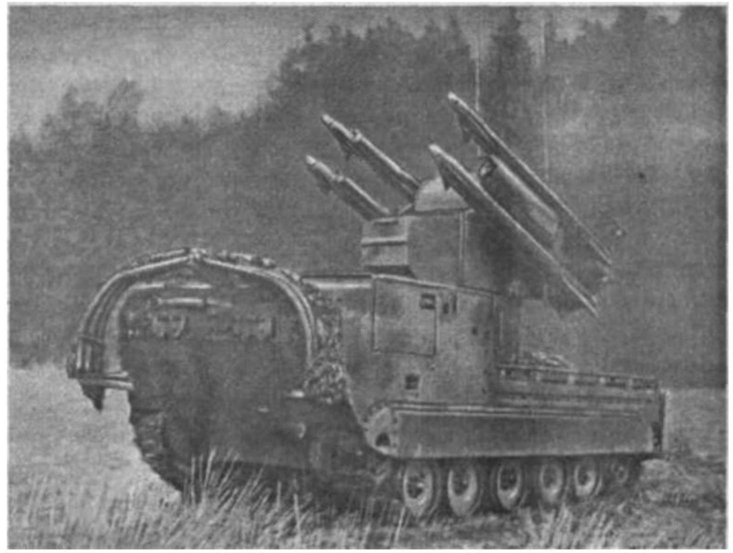
Maximum range of destruction of aerodynamic targets, km	100.0
Destruction height, km:	
maximum	30.0
minimum	0.05
Height of destruction of ballistic missiles, km:	
maximum	25.0
minimum	1.0

TACTICAL AND TECHNICAL CHARACTERISTICS OF MISSILES

	9M83	9M82
Length, m:		
rockets	7.89	9.91
rockets in TPK	8.57	10.52
Diameter, m:		
rockets	0.91	1.21
rockets in TPK	9.3	1.46
Weight, kg:		
first stage second	2275	4635
stage	1213	1271
Average missile speed, m/s Probability	1200	1800
of destruction:		
airplane	0.7—0.9	
missiles "Lance"	0.5—0.65	
warhead	0.4—0.6	
"Pershing" "SREM"	0.5—0.7	

"Chaparral"

(USA)



One of the first steps towards creating an all-weather anti-aircraft missile system in the United States was the program to create the Mauler air defense system. For many reasons, and primarily because of the cost unacceptable for mass production, the American

specialists were unable to achieve all specified characteristics.

At the same time, the successes of Western European countries in creating mobile short-range air defense systems (Rapira, Crotal, Roland 1, Roland 2 complexes) forced the leadership of the US military department to deploy and finance a number of programs , such as the development of the Chaparral self-propelled air defense system and the Vulcan anti-aircraft artillery systems in self-propelled and towed versions.

The upgraded Sundwinder-1a air-to-air missile (AIM-9D) with an infrared homing head was used as a missile for the Chaparral air defense system.

Denia.

The creation of the complex began in 1964, and acceptance armament by the American army took place in 1969.

The standard configuration of the Chapar-ral air defense missile system consists of two main elements: the M730 tracked chassis, based on the M548, and the M54 launcher. Crew - 4 people: squad leader (during the battle he selects targets, identifies them and determines the order of firing at the target), senior gunner (works with the launcher and controls the station, and if necessary replaces the commander), driver (observes the air situation and, if necessary, acts as a radio operator) and a second (reserve) gunner, whose task is

rogo - finding the goal.

If necessary, the crew composition allows for combat I work for 24 hours or more.

The M730 chassis has an engine compartment and a compartment for combat crews. Its places are located in the front of the chassis on the sides. The chassis is equipped with a torsion bar suspension and a driver's IR monitoring system. The chassis is amphibious; tracks are used as propulsion on water. The launcher and control station combined into the M54 consist of an engine with an electric generator,

space for storing missiles, crew locations and other necessary equipment, as well as a launch platform. The senior gunner's compartment, located in the turret, is equipped with air conditioning and an adjustable seat. Like all military systems, the chassis has a filter and ventilation unit. The engine can be gasoline (M48 and M48A1) or diesel (M48A2 and M48AZ), together with a generator they provide power to all equipment. If a power unit fails, combat work can be continued for a short time thanks to on-board batteries.

Information about the technical condition of the missile and the complex is displayed on the control panel using switches and indicators, which allows you to control the preparation of the complex’s systems, select a missile for firing, determine their launch sequence, and also test the combat vehicle’s systems. Each missile launcher has “friend or foe” system equipment for target recognition.

The MIM-72A missile has a cruciform shape with two pairs of rudders in the front and two pairs of rudders in the rear

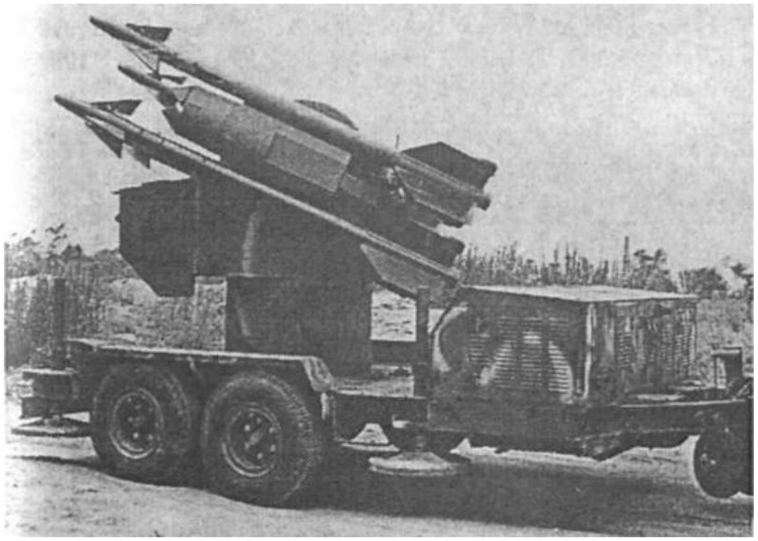
parts.

The launcher contains four missiles in combat in good condition, eight more missiles are in ammunition.

A modernized missile equipped with a new seeker, under the designation MIM-72C, was put into service in 1978. Its launch weight is 85.7 kg, and it has a new high-explosive fragmentation warhead M250. The new IR seeker is designated AN/DAW-1B. Effective range increased to 9000 m. Subsequent modifications

The missiles are powered by the M121 low-smoke rocket engine.

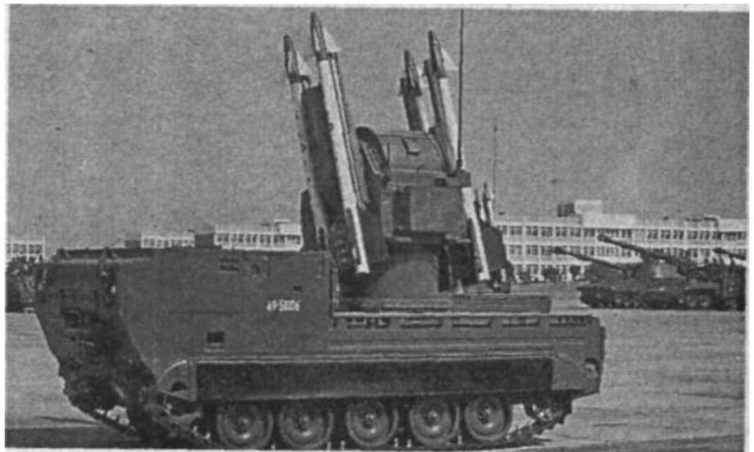
Destruction of a target during daylight hours occurs as follows. Notification of the presence of a target comes from the AN/MPQ49 radar or from a visual observer. As soon as a target is detected, the shooter, by rotating the launch platform, ensures that the target hits the center of the sight or the center of the field of view of the IR sight. The launch platform can rotate 360° (circularly) in azimuth and elevation



Complex "Chaparral", placed on a semi-trailer

from -9° to +90°. After capturing the target, a tone signal is heard in the shooter's headphones (the same happens when the target enters the IR viewing area) and he launches a missile created according to the "fire and forget" principle. Rocket control commands using the proportional approach method are generated from the tracking system and transmitted aboard the rocket. The contact fuse ensures that the warhead will detonate even without the missile directly hitting the target. The use of the "fire and forget" principle in a missile allows, after finishing firing at one target, to begin searching for another, capture it and destroy it without waiting for the first target to be hit. The rate of fire of the complex is 4 missiles per minute, with a total reloading time of 5 minutes. The probability of hitting a single target with a speed of up to 550 knots (1028.5 km/h) is 0.5 and increases significantly for subsequent missile modifications. The flight range of the basic missile is from 500 to 12,000 m at an altitude of 15 to over 3,000 m, and the destruction of a helicopter type target with a probability not lower than the specified one is carried out at ranges of up to 8,000 m, and of an aircraft target - at ranges of up to 9,000 meters.

The new seeker, called Rosette Seeker (RSS) and designated AN/DAW-2, entered service in 1987 and was assigned the code MIM-72G.



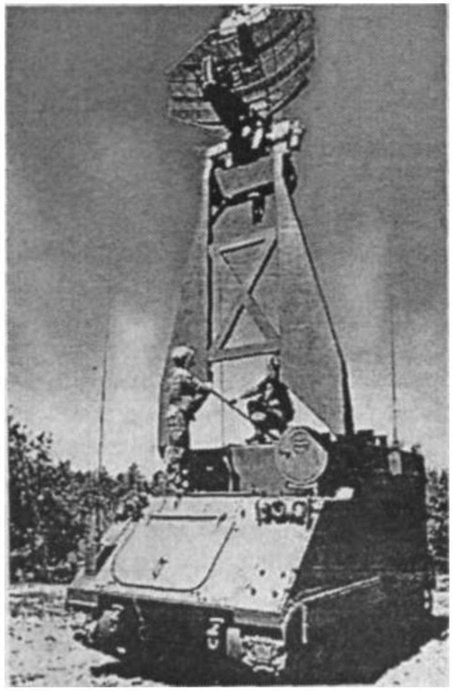
Комплекс «Chaparral» тайваньских вооруженных сил

The fundamental difference between the RSS seeker is its software, which can be reprogrammed in the presence of various IR traps, for example, those fired from an airplane. GOS provides bakes a two-color spectral discriminatory characteristics. This helps identify the target against the background of IR traps. Improvement of the export

version of the MIM-72G missile under the designation MIM-72J made it possible to increase target targeting accuracy by 50% thanks to the use of a seeker

AN-DAW-1 and low-smoke rocket engine Ml21, proximity fuse M817 and high-explosive fragmentation warhead type M250. True, it lacks the ability to distinguish targets against the background of IR interference.

The MIM-72G missile during testing showed the possibility of grip for automatic tracking and destruction of targets such as a helicopter at ranges over 9000 meters, capture at



Radar detection control system

automatic tracking of aerodynamic targets at ranges of 16,000 m and their destruction at ranges of 9,000 meters. Also computer modeling of the possibility of intercepting and destroying certain types of tactical ballistic missiles when captured by auto tracking at ranges of about 22 km was confirmed.

The manufacturer of the Chaparral complex (Lockheed Martin Aeronutronic) claims that this has achieved the ability to combat all possible types of IR traps. The far border of the affected area has been increased using the RSS type seeker. Target targeting accuracy has been increased by 50%. Real firing at helicopter-type targets at ranges of over 8,000 meters and aerodynamic targets at ranges of 12,000 meters was completed successfully.

Production of the complex has been completed, but can be resumed if circumstances require. It is in service with Egypt (50 air defense systems), Israel (52), Colombia (5), Morocco (37), Portugal (5), USA (523), Taiwan (45), Tunisia (26).

TACTICAL AND TECHNICAL CHARACTERISTICS OF THE MIM-72G MISSILE

Damage range, km:	
maximum for a helicopter maximum for	8.0
an aerodynamic target minimum Damage height, km:	9.0
	0.5
maximum	over 3.0 0.015
minimum	2.91
Rocket length, m	0.12
Rocket diameter, m	0.63
Wingspan, m Weight, kg:	
missile	86.2
warhead Warhead	12.6
type	high-explosive fragmentation with contact fuse Maximum missile

speed, M over 1 Reloading time, min 5 Solid propellant engine Missile guidance method proportional rendezvous with passive IR homing

"Avenger"

(USA)

Self-propelled anti-aircraft missile system "Avenger" (“Avenger”) is designed to engage air targets at ranges of 0.5–5.5 km and at altitudes of 0.5–3.8 km on a collision course and in pursuit.

The development of the complex was started by the Boeing Aerospace Company in the early 80s. The time from the formation of the concept of building the system to the start of testing was only 10 months.

In May 1984, the first three launches were carried out against air targets in various conditions (on the move, at night and in rain) and a direct hit was noted. All launches were carried out by operators who had not previously fired. In August 1984, 178 mobile launches were carried out.
large and stationary targets in day and night conditions, 171 of them were hit.

In November 1988, the first air defense systems produced were put on combat duty. A total of 1,800 Avenger air defense systems were produced .”

J SAM is a gyro-stabilized platform on which the Stinger missile defense system is installed in the TPK - 2 packages of 4 pieces, optical and thermal imaging means for detecting and tracking targets, a laser range finder, an identification device of the AN/PPX type - 3B (from the Stinger MANPADS), control and display systems, radio stations AN/PRC-77 and AN/VRC-47 (in the future the AN/VPvC-91 SINCGARS radio communication system may be installed), 12.7 mm machine gun. All equipment, with the exception of missiles in the TPK, thermal imaging and television cameras and a machine gun, is located inside the cabin, where the operator's workplace is equipped. Containers] can accommodate Stinger missiles of any modification, without requiring any changes to the system. The missiles can be raised at an angle from -10 to +70°. The PMS (Pedestal-Mounted Stinger) platform is mounted on an all-terrain vehicle like the M988 Hummer. PMS can be installed on other types of chassis such as Bv206, M548 and M113AZ. The Avenger is fully air transportable by the C-130 Hercules or C-141B Starlifter aircraft. Externally mounted air defense systems can be carried by UH-60, CH-47, CH-46, CH-53 helicopters.

For the US Army, PMS uses Stinger anti-aircraft missiles, but other detection systems and other missiles can be adapted, including laser-guided HYDRA-70 or RBS-70 unguided missiles. “Avenger” is made according to a modular design, which allows the use of other target detection systems, including extended-range detection systems.

The control unit can be rotated 180°, allowing the operator to control firing while sitting in the passenger seat. The control unit can be removed from the machine and placed at a distance of up to 50 m to ensure the safety of the crew.

The PMS can be rotated 360° in azimuth. If required, the PMS can be removed from the HMMWV and then used as a stand-alone fire unit in a stationary configuration. A 24 V DC source is used to power the electrical components of the system. The operator has a large transparent dome for visual observation of the air situation, in which he also sees the projection of the aiming point. Point of sight-
The firing corresponds to the direction of rotation of the missile's homing head and confirms to the operator that the missile's seeker has captured the target selected for firing. The detection system

includes a CAI optical range sight, a Magnavox AN/VLR-1 (or IR-18) thermal imager, an automatic target tracking device, and a laser range finder, which allows you to detect, capture and automatically track air targets at the required ranges . The thermal imager is equipped with an electric drive and is installed on the left below the missile container. This is a self-contained system operating in the wavelength range from 8 to 12 microns. The operator tracks the target visually using an optical sight, or using a thermal imager in bad weather and at night. The system is capable of automatically tracking a target, determining the distance to the target, and firing while moving at a speed of up to 35 km/h.

Automatic target tracking (AVT - automatic video tracker) provides an automatic tracking module that detects current misalignment errors in azimuth and angle and turns the platform towards the target. The laser rangefinder is installed on the left side under the thermal imager. The measured range to the target is processed by the electronics of the Aven-

jera" and is used for automated launch when the target enters the launch zone. The mark for permission to open fire in the form of a special symbol appears on the display of the thermal imager and optical sight. This allows you to fire at targets at maximum ranges. The rotating platform is gyrostabilized to maintain the direction of the missile container regardless of movement

tion of the machine.

The operator has a manual regulator (steering wheel), with which he deploys the missiles and machine gun in the direction of the target. After manually tracking the target, the operator can
transfer control to automatic tracking systems. This allows the operator to concentrate on the target distribution. Operations are fully automated and
the operator only has to press the launch button and immediately select and prepare the next missile for launch.

For self-defense and covering the Stinger's dead zone, a large-caliber 12.7-mm MZR machine gun is used, which is an improved version of the AN-M3 MG with a rate of fire of 1100 rounds per minute and an ammunition capacity of 300 rounds. The machine gun can be installed on either side under the missile container. In addition to the eight missiles

in combat position in the TPK, there are eight Stingers in reserve. Recharging takes less than 4 minutes. The Turkish company Aselsan offers a air defense system (PMADS), the

construction of which is similar to the Avenger and which initially used the Stinger missile.

The complex was supplied to Taiwan and South Korea.

TACTICAL AND TECHNICAL CHARACTERISTICS OF THE FIM-92C MISSILE

Damage range, km: maximum	5.5
minimum	0.2
Damage height, km:	
maximum	3.8
minimum	ground level 2.2
Maximum rocket speed, M Weight, kg:	
missile	10.1
warhead	h
Rocket length, m	1.52
Rocket diameter, m	0.07

FIGHTING MACHINE

Crew, people	2
Weight, kg	3900
of the platform	1134
Width with the vehicle, m Height, m	2.18
Platform	2.59
length, m Platform width,	2.13
m Maximum speed of the	2.15
combat vehicle, km/h Cruising range, km	105
	563

LAV-AD

(USA)

The anti-aircraft missile and gun system is designed to combat aircraft and helicopters using missile and gun weapons and, as an auxiliary task, can be used to combat ground targets using cannon weapons. Typically, the Stinger missile defense system is used to engage targets at ranges up to 6000 m, and guns at ranges up to 2500 m. The complex was developed by order of the command of the US Marine Corps. Initially it was assumed that it would be equipped with one container with unguided HYDRA-70 missiles, one with a Stinger missile defense system and a 25-mm cannon. However,

during the development process, it was decided not to install a container with unguided missiles, but instead to mount another container with a Stinger missile defense system. The LAV (Light Armored Vehicle) armored personnel carrier, already used in the Marine Corps, was chosen as the chassis.

Tests of the complex were carried out in June 1992. Pro-production of the complex began in 1996.

The complex (turntable or turret) consists of the following main elements:

• basic kit including 25 mm GAU-12/U cannon "Gatling" from Lockheed Martin and 8 anti-aircraft controls

fired Stinger missiles in transport and launch containers nerah;

• detection system, including thermal imaging and television detection cameras, laser range finder,

automatic tracking system and control system fiery fire.

To detect targets in day and night conditions, a combined sight (PSS - Primary Sight System) is used, combining television and thermal imaging cameras. A laser rangefinder is used to measure the range to tracked targets. The range is necessary to determine the moment of launch of the missile defense system and select the type of weapon to fire. The crew of the complex is 2 people: commander and operator. Everyone is capable of independently detecting and tracking targets, as well as choosing the type of weapon to fire at targets. Target detection is carried out using PSS or visually through armored glass on the front and sides of the operator's cabin. The air defense missile system is equipped with a digital fire control system.

The chassis of each complex has ammunition of 8 missiles. Each combat vehicle also has a 7.62 mm machine gun for close defense and two blocks of four electric

chemically controlled smoke grenades.

The missile defense system, cannon, as well as detection equipment are located on an electrically controlled gyro-stabilized platform, which allows firing at targets both from the spot and

in move.

The system can be installed on other types of chassis, such as Alvis Stormer, MPZ, Bradley and Pirana (8x8).

A further development of this system was the joint development of Thomson-CSF and Lockheed Martin, called “Blaser”. It is armed with the Mistral missile defense system and the Thomson-CSF TRS 2630 radar, which is capable of detecting targets at ranges of up to 20 km, including fighters at a range of up to 17 km, and hovering helicopters up to 10 km. The RAS is equipped with a phased array antenna and allows for automatic target tracking and friend-or-foe identification. This complex, compared to the prototype, has less ammunition for missiles and shells.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km: maximum	
(missiles/gun) minimum (missiles/gun)	5.5/2.5
Damage height, km:	0.2/0
maximum	3.8
minimum	ground level 2.2
Maximum rocket speed, M Gun caliber,	25
mm Rate of fire, rds/	
min. Firing sector by angle, degrees.	1800
Firing sector in azimuth, degrees.	-8 +65
Maximum speed of rotation of the platform	360
rad./s Maximum acceleration of rotation of the platform rad./s2 2	1
Crew (crew), people. 2 Ammo:	
missiles	900
	16
missiles Weight, kg:	
together with the	13 410
platform chassis	• 2676

M2A2 "Bradley linebacker"

(USA)

In 1995, Boeing adapted the Stinger missile system for the Bradley infantry fighting vehicle. The new Bradley Linebacker short-range air defense system is designed to combat airplanes, helicopters, cruise missiles and unmanned aerial vehicles. The new air defense system can perform its functions day and night in any weather conditions, while on the march or

taking a stationary position.

The complex entered service in November 1997. In March 1998, the air defense systems took part in maneuvers aimed at developing new tactical techniques for conducting modern combat, as a result of which another 85 Linebackers were adopted by the US Army. The Linebacker system is based on the Bradley infantry fighting vehicle of the M2A2 or M2A0 modifications, on which a standard launcher with

four Stinger missiles is mounted.

(FIM-92C). The ammunition load is supplemented by 8 spare missiles. "Stingers" are two-stage solid propellant

missiles that self-guide after launch

at the target using a homing head operating in two modes - infrared and ultraviolet. Thus, the "fire and forget" principle is implemented. The length of the rocket is 1.5 m, diameter 70 mm, weight 10 kg (with a 3-kg high-explosive fragmentation warhead). Its maximum speed is M2.2, its firing range is from 200 m to 4500 m, its maximum altitude is 3800 m. A digital compass and a gyro-stabilized turret ensure

ensure continuous tracking of the target while the vehicle is moving. The on-board computer constantly aims the launcher at the selected target, which saves time on searching and capturing it. Turret rotation and capture

targets are made automatically when the corresponding button is pressed on the control panel of the combat situation monitor of the vehicle commander. The target classification and its coordinates,

as well as the current state of the Stinger missile and homing head data are displayed on the gunner's integrated sight to confirm the launch command. The complex sight has optical, television and thermal imaging channels.

The monitoring, control and communication equipment of the Linebacker air defense system is connected to the small air defense communication network range using a portable electronic terminal - la, which includes an improved system location determination and single-channel radio station with a signal coding system.

The Bradley Linebacker is armed with a 25mm M242 Bushmaster automatic cannon with a rate of fire of 200 rounds/min. A 7.62-mm M240S machine gun is paired with the cannon. Four M257 smoke grenade launchers are mounted on each side of the gun.

When driving on the M2A2 highway, the Bradley Linebacker reaches a maximum speed of about 60 km/h. When overcoming water obstacles, the car moves at a speed of 6.4 km/h. The range when driving on the road exceeds 400 km.

The vehicle is air transportable and can be deployed military transport aircraft C-141, C-5 and C-17.

Subsequently, the Bradley chassis and hull were used in the development of another military air defense system - a short-range anti-aircraft missile and artillery system.

ness. It is armed with two launchers - transport containers for 8 Stinger anti-aircraft guided missiles and a 25-mm automatic 6-barreled Gat-ling cannon, the ammunition load of which includes 310 rounds. The gun's rate of fire is 1800 rounds/min. The complex is equipped with an electronic fire control system, target detection radar, infrared, television sights and

laser range finder.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum	4.5
minimum	o.5
Damage height, km	z.8
Missile length, m	1.52
Missile diameter, m	0.07
Missile wingspan, m	0.09
Maximum missile speed, M Firing	2.2
range, km:	
minimum	0.2
maximum Crew, ,	4.5
people Chassis	
weight, t Length,	4
m Width,	29.9
m Height, m	6.55
* Armament:	z.61 2.97
Stinger missile	
launcher	4 FIM-92C missiles (plus 8 missiles ammunition)
25-mm automatic cannon M242 "Bushmaster"	300 rounds (plus 300 rounds of ammunition) 800
7.62 mm M240S machine gun	rounds of ammunition (plus 2,800 rounds of ammunition)
Maximum chassis speed, km/h:	
along the highway	61.0
afloat	6.4
Cruising range on the	400
chassis, km Obstacles overcome, m:	
wall height .	0.91
ditch width	2.54

"Donets"

(UKRAINE)

The Donets self-propelled anti-aircraft missile and gun system was developed by the Ukrainian state plant named after. Baby-
VA and is intended mainly for export supplies.

It is a combat vehicle created on the basis of the main battle tank T-80U, on the chassis of which an improved turret from the Russian Shilka self-propelled gun system is installed. The chassis of the Russian tanks T-54/55, T-62, T-72, as well as tanks of a similar type made in China, can serve as a base for the Donets self-propelled air defense missile system. "Donets" has higher maneuverability and a significantly higher degree of protection compared to the lightly armored "Shilka".

On the sides of the Donets air defense missile system turret, transport and launch containers with two Stre-la-10M anti-aircraft missiles are mounted, which are capable of hitting air targets located at a distance of 5000 m and an altitude of 3500 m. The artillery part

of the air defense missile system remained unchanged : The turret contains a quadruple 23-mm water-cooled anti-aircraft gun AZP-23M with a rate of fire of 800-1000 rounds per minute per barrel. The effective slanted firing range at air targets is 2,500 m. Compared to the Shilka, the Donets' ammunition load is doubled and amounts to 4,000 rounds.

Despite the fact that the detection and tracking radar antenna remains on the roof of the tower, instead of the old fire control system, the vehicle is equipped with a new digital computer system, data transmission facilities and a navigation system. The ZRPK crew consists of 3 people.

To increase the internal volume, the chassis body was made higher compared to the T-80U tank. An auxiliary power unit is installed on the right at the rear of the hull, which ensures the operation of all vehicle systems when the main engine is turned off. On paved roads, the 35-ton Donets air defense missile system reaches a maximum speed of 65 km/h, and on rough terrain - up to 40 km/h

The Donets air defense missile system battery can consist of four or six combat vehicles and one control vehicle on the same chassis. A three-dimensional radar is mounted on the roof of the control vehicle, providing a complete picture of the air situation and information about the location of other air defense systems. Information about
targets are displayed on crew monitors and can be transmitted over a distance of 2500 m. It is possible to receive target designation from other external sources.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km: for cannon	
weapons, maximum	2.5
for missile weapons:	
by range	0.8-5
in height	0.025-3.5
Speed, m/s:	
missile flight, average	517
target hit Probability	415
of defeat:	
for missile weapons Total rate of fire,	0.1-0.5
rds/min Weight, kg: missiles, missile warhead	up to 4000
Ammunition:	
23 mm	40
cartridges, pcs. Weight of the	3
air defense missile	
system, t Speed of the air	4000
defense system, km/	35.0
h: on the road over rough terrain	
	up to 65
	up to 40

SANTAL

(FRANCE)

The SATCP Mistral (Systeme Anti-aerien a Tres Courte Portee) man-portable anti-aircraft missile system can be integrated with various types of army chassis. After studying the VAB and Panhard ERC (6x6) chassis, the latter was selected for adoption by the French armed forces. However, for financial reasons the project was terminated, although military tests were completed in 1990.

The turret system with launchers SANTAL (Systeme Anti-aerien Autonome Leger) was designed by Hispano-Suiza and has three missiles on each side, ready for immediate use. There is an ammunition reserve of six missiles located inside the chassis. The Rodeo 2 pulse-Doppler radar is mounted on the front part of the tower system.

The first prototype of the turret system (POl), created by Hispano-Suiza in 1987, was mounted on a Panhard ERC chassis, the second - in the same year on a VAB tracked chassis (6x6). The Matra company was the first contractor to create a full-fledged air defense system, which included a Castor-type thermal imager, Rodeo 2 radar, friend-or-foe identification systems and two launchers with three missiles each.

The missile ammunition is located in the chassis body, three on each side. The possibility of manual reloading is provided on the Panhard ERC chassis.

The tower system has a mass of 1800 kg with six missiles. For self-defense, a 7.62-mm machine gun is installed in the upper part, there are also four smoke bombs that can fire electrically driven to camouflage the chassis.

The full combat crew of the complex consists of three people: a radio operator - the chassis commander, a missile guidance operator and a driver. The turret system houses the fire control system equipment and the radar control panel. The tower system rotates 360° in azimuth at a speed of 50 degrees/s using an electric drive. Rockets, finding-

Комплекс SANTAL на шасси «Piranha» 8x8

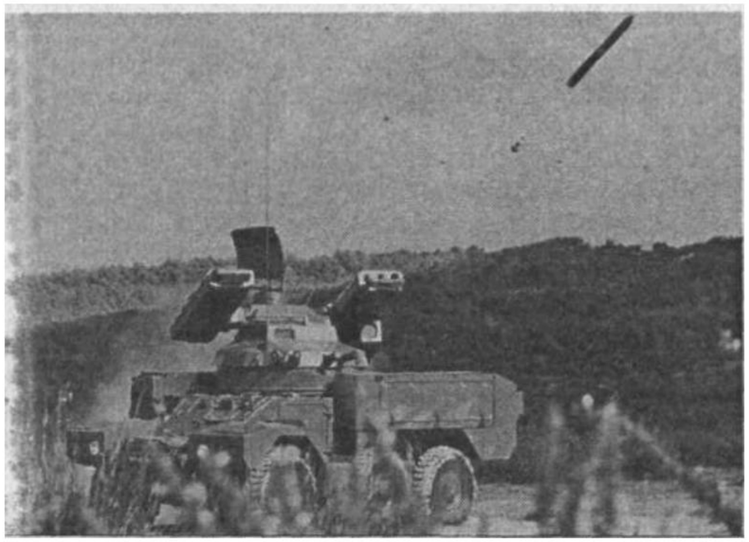
located on launchers can change their position in elevation from -10° to +60°. In case of unforeseen circumstances, it is possible to switch to manual control of the rotation of the tower system. The guidance operator has periscope devices for all-round visibility of the area and a day sight of the Sopelem M411 type with six-fold magnification, located in the front part of the roof of the turret system, as well as a thermal imager of the TCO Castor type with two fields of view, mounted on the left side. There is an armored

(hatch, opening to the rear.

Detection and destruction of the target occurs as follows. The surveillance radar detects the target first, and if it is hostile, the missile turret system rotates in the azimuth direction towards the target. Opera-

torus searches for a target using a thermal imager or optical sight. When a target is detected, it is automatically captured for tracking, thereby allowing the combat crew to proceed to other stages of combat work. When the target enters the affected area, a launch is carried out

rockets.



SANTAL complex on Panhard 6x6 chassis

The Rodeo 2 radar can detect helicopters camouflaged on the ground at ranges over 6 km, and those in open positions at ranges over 8 km. The detection range of flying airplanes and helicopters exceeds 12 km. Two targets can be tracked at the same time. The radar is capable of recognizing and identifying a flying aircraft

tolet from standing on the ground. -

The 3-kilogram warhead of the missile contains a large number of tungsten fragments and has a laser non-contact fuse with a range cutoff. It reduces the influence of reflections from the surface of the earth or sea and protects against premature operation. There is also a contact fuse.

The missile's infrared homing head allows destroy planes and helicopters when approaching them from any angle. The maximum speed of the rocket is M2.5. The minimum and maximum target engagement ranges are 300 and 6000 meters, respectively.

At the beginning of 1993, the SANTAL turret system was mounted on the chassis of the Russian BMP-3 and the Swiss MOWAG Piranha (8x8 wheel arrangement). The first option was intended for the United Arab Emirates, the second - for Saudi Arabia.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum (depending on target type) 5.0—6.0 0.3	
minimum	
Damage height, km:	
maximum	3.0
minimum	0.005
Rocket length, m	1.86
Rocket diameter, m	0.0925
Wingspan, m Weight, kg:	0.2
missile	
warhead	19.0
Maximum rocket	12.6
speed, M Warhead type:	2.5
	high-explosive fragmentation with contact and non-contact fuses Reloading time, min no
data Missile guidance method passive infrared homing	

"Crotal"
(FRANCE)

In 1964, South Africa entered into a contract with the French company Thomson-Houston (later renamed Thom-son-CSF) to create a mobile all-weather air defense system with surface-to-air missiles, designed to destroy targets flying at

low and extremely low altitudes.

The complex being created received the South African name "Cactus". After tests carried out in 1971, the first Cactus complexes were delivered to South Africa within two years. After intensive testing commissioned by the French Air Force in 1972, this complex, called Cro-tal, was adopted by

the French Air Force. The complex is designed for air defense of air bases. By 1978, 20 Krotal air defense systems had been put into service.

Typically, the equipment of the Crotal complex is mounted on a P4R chassis (4x4 wheel arrangement) and can be placed
in a stationary version.

The first Crotal complexes were produced under the code "1000 series". Since 1973, the "2000 series" entered production, in which the complex was equipped with a state identification system and a TV camera, the "3000 series" of the complex began to be produced in 1978 and was adopted only by the French Air Force; In the complexes of this series, a mode of automatic target tracking using a TV camera was implemented.

"Series 4000" began to be produced in 1988 (radio communication equipment appeared, allowing the exchange of information between combat control points at a distance of up to 10 km and the distance of launchers from the combat control point to 3 km). Finally, starting in 1994, a modernized version of the complex began to be produced - Improved Crotale.

In the Krotal complexes of the 3000 series, after the march, time was needed for the cable connection of the combat control point and the launchers; the maximum cable length was 800 m. Thus, the time to bring the complex into combat position was a significant amount. Therefore, the "4000 series" complexes are equipped with LIVH (Liaison Inter Vehicule Hertzienne) - radio communication equipment and a mast device. In addition to significantly reducing the time it takes to bring the complex into combat readiness and increasing the distance between the combat control point and the launch

new installations have increased its noise immunity,
the complex is given the ability to conduct combat work without RAIS radiation - with the help of a thermal imager that carries out
tracking of targets and missiles both during the day and at night
conditions.

In November 1988, at the second arms exhibition AZIAN-DEX, the Chinese corporation CPMLEC presented the FM-80 air defense system, placed on biaxial trailers, which has much in common with the French Crotal complex.

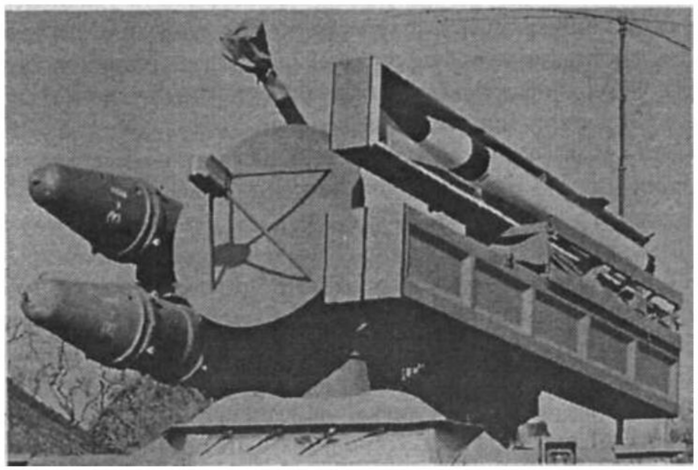
The Krotal complex is operational in all weather conditions. A typical platoon consists of an combat control unit (ACU) and two to three launchers per battery

(division) includes two platoons. The complex cannot conduct combat operations while moving, but after stopping it requires less than 5 minutes to be brought into combat readiness.

The chassis has an armored body. The driver's seat is located in the front part, the operator's workstations and all equipment are located in the center of the body. The engine compartment occupies the rear part. There is an exit on the right side of the body; the hatch cover rises up. The chassis is equipped with an air conditioning system.

After detecting and locking on a target for tracking, the missile can be launched within 6.5 seconds. The speed of destroyed air targets is up to Ml.2, and the flight altitude is from 50 to 3000 m. The effective dispersion surface of air targets should be 1 m^2. All information in the "4000 series" complexes is transmitted from the combat control point to the launchers via cable over a distance of up to 800 m or via radio communication.

The combat control point monitors the airspace, detects a target, recognizes its nationality and recognizes its type. Mirador IV E-band pulse-Doppler detection radar mounted on top of the chassis body, has a rotation speed 60 rpm and is capable of detecting low-flying targets at



Launcher: left "Cactus" R-440, right SAHV-3

ranges up to 18.5 km, having a flight speed in the range from 35 to 400 m/s and a flight altitude from several tens to 4500 m. The equipment of the combat control point includes: a computer operating in real time, a panel with displays and communication equipment that transmits information in digital code to the launchers. A similar computer is installed on the launcher and is used to calculate target track data and display it on displays. The radar can detect up to 30 targets, highlighting the 12 most dangerous of them for automatic technical support.

As soon as a target is detected, state identification of its identity is carried out: information that the target is an alien aircraft is displayed on the display. Data about someone else targets are transmitted using communication equipment to one of the launchers, where there are combat-ready missiles.

The launcher is equipped with a monopulse missile guidance radar with a far limit of the detection zone of up to 17 km and 4 missile guides (two on each side).

The launcher has an antenna with a 10° beam pattern control for transmitting guidance commands to the missile, equipment for measuring the guidance error of the IR tracking system, a unit of the TV tracking and guidance system, an optical surveillance system, which is used in a complex radio-electronic interference environment and, if necessary, allows for an overview of the space without radio emissions. There is a digital computer, operator console and communication equipment. All chassis are combined using radio links into a kind of network, and it is possible to transfer information to the launcher not only from the combat control point, but also from another launcher.

The radar on the launcher can track one target and guide up to two missiles at it simultaneously. Missiles launched at intervals of 2.5 s are captured by a capture beam with a radiation pattern width of 1.1°, generated by the missile guidance radar.

It is also possible to aim the missile at a target using a TV system. In this case, commands to point the missile at the target are transmitted using a remote system.

-

There is no missile ammunition on the launch chassis, so spare missiles are transported in a special vehicle and reloading is done using a light crane. A well-trained crew of three people is capable of reloading 4 missiles in 2 minutes. The R-440 missile weighs 84 kg, total length is 2.89 m, wingspan is 0.54 m and diameter is

0.15 m. The missile is constantly located in a transport and launch container. The total weight of the rocket with the TPK is

100 kg. A directional high-explosive fragmentation warhead weighing 15 kg is located in the central part of the rocket body. The striking radius of dispersion of fragments is 8 m, and the dispersion speed reaches 2.3 m/s. The warhead is detonated using an IR non-contact or backup contact fuse. Since 1985, the Krotal complex missile has been equipped with a modernized FPE model fuse from Thomson-CSF.

The SNPE Lens ÿ rocket engine contains 25.45 kg of solid fuel. The rocket reaches its maximum speed of 750 m/s in 2.8 seconds of flight. The naval version of the Crotal complex is equipped with a modified R440N missile.

For targets with an effective dispersion surface of 1 m^2, zero and non-zero parameter, flying at speeds of 50 m/s and 250 m/s, respectively, main values |

The boundaries of the affected area are given below:

Target parameter (P)	Target speed, m/s 50	250
p=0		
Damage range, km:		
maximum	10.0	9.5
minimum	0.5	0.5
P>0		
Damage range, km:		
maximum	9.7	5.5
minimum	0.5	2.0
Damage height, km:		
maximum	5.0	4.5
minimum	0.015	0.015

The probability of hitting a target with one missile is 0.8 and increases to 0.96 when firing two missiles at a target.

The maximum range at which the Crotal complex can destroy targets with low radial speed (for example, a helicopter), is 14.6 km.

OVERLOAD CHARACTERISTICS OF THE ROCKET:

Flight range, km	G-force, g	Flight time, s
5.0	27	10
6.0	18	13
10.0	8	28
13.0	3	46

At the beginning of 1987, a new warhead for the Crotal missile was tested. It used space-time convergence technology to create a fragment scattering area in the form of a belt with a diameter of 40 cm, formed at a distance of 5-8 m from the target, depending on the value of the missile miss. The fragmentation part has increased penetration power, allowing it to pierce a steel plate up to 10 mm thick or tear out large pieces of aluminum skin of the target.

In 1975, Saudi Arabia ordered a modernized version of the complex, capable of being placed on various types of chassis, in particular on the AMX-30 chassis. The air defense system received its own name “Shahihe”. In addition, Saudi Arabia purchased the basic version of the Krotal complex, and in 1990, a modernized version of the complex to protect its air bases.

As of 1996, about 275 complexes (of which 25 were sea-based) and more than 7,000 missiles were produced. The complex

was supplied to Bahrain, Egypt, Libya, South Africa, and South Korea. Currently, potential

buyers are offered the KrotaL-NG complex, which has the best tactical

technical characteristics and noise immunity.

TACTICAL AND TECHNICAL CHARACTERISTICS OF THE R440 ROCKET

Length, m	2.89
Diameter, m	0.15
Wingspan, m Warhead	0.54
mass, kg Maximum speed,	
m/s Reloading time for 4 missiles,	
min Warhead type Engine Guidance system	15,750 2
	high-explosive
	fragmentation solid
	propellant command

"Shahine-1", "Shahine-2"

(FRANCE)

In 1975, Thomson-CSF signed a contract with Saudi Arabia for the design, creation and production of a mobile, all-weather air defense system, Shahine-1, designed to combat targets flying at low altitudes. The contract provided for the supply of several batteries of the Shahine-1 complex, each of which included two target detection systems and four firing units mounted on a modified MVT AMX-30 chassis. The batteries were to be supplied to Saudi Arabia between 1980 and 1982.

To conduct joint combat operations with Shahine-1 batteries, Saudi Arabia acquired twin 30-mm anti-aircraft guns mounted on the AMX-30 chassis.

The basic version of the Shahine complex is mounted on an AMX-30 MVT type chassis, which has improved cross-country ability in desert terrain. The detection system consists

of a pulse Doppler survey PAC of the E/F range with a detection range of 18,500 m (detection altitude - 6000 m), a digital receiver channel for the implementation of MDS (MP - moving target

Indication - selection of moving targets). The data is processed on a computer, which makes it possible to track up to 40 targets and automatically identify the 12 most dangerous of them. The TV system is located on its turret; it provides optical reconnaissance of the area and targets while the complex is moving.

The firing unit consists of a monopulse Doppler RAS | range (range - 17,000 m). The RAS simultaneously tracks the target, as well as one or two missiles aimed at the target. The RAS has a digital receiver and a circularly polarized antenna. The fire unit enters

dit missile guidance system using the remote control method.

During the initial phase of the flight, the missile is captured for tracking using IR sensors. When interference occurs on the RAS, a transition occurs to the TV system, which carries out target tracking and missile guidance. The ammunition capacity of the finished missiles is six. When the ammunition is used up, reloading is carried out, the missiles are delivered on a transport and loading vehicle of the MTLV type (missile transport and loading venicle).

The R460 missile of the Shahine complex is a modernized version of the R440 missile of the Crotale air defense complex. It has a length of 3.12 m, a diameter of 0.156 m and a wingspan of 0.59 m. The total weight is 100 kg, of which 15 kg is a directed-action fragmentation warhead. The warhead is triggered either by a passive IR fuse or by a contact fuse. The radius of destruction of the warhead (the speed of fragmentation is 2.3 m/s) is 8 m. There is a section behind the nose cone-shaped part of the rocket, which contains the contact fuse. It

houses the pitch and heading control system of the rocket, as well as the drive of the heading damping system.

I [the last system controls the rudders, made according to the “duck” design. Next in the rocket there is a power battery, an electronic control unit and other necessary systems, including the warhead. The next section houses the rocket engine, which accelerates the rocket to a maximum speed of 2.8M. Solid fuel is produced by ENPE. The burning time is about 4.5 s.

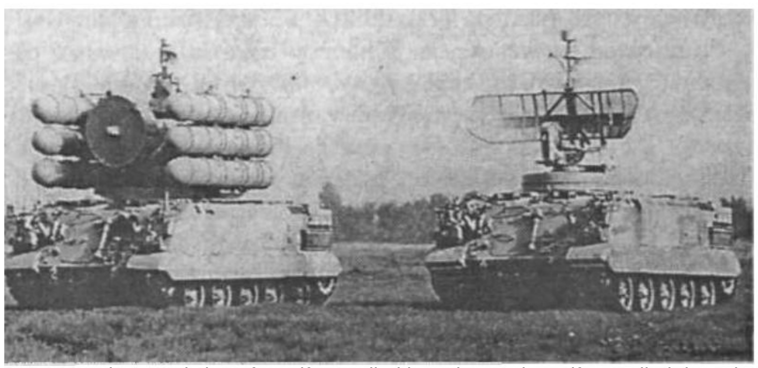
The last section of the rocket contains the receiver and transmitter, rudders, IR tracer and nozzle. Thomson-

CSF is the main manufacturer of radar equipment and electronics, and Matra is the main manufacturer of missiles. The IVPDL (Inter-Vehicle Position and Data Link) communication system allows the

detection node and the firing node to be separated at a distance of up to 4000 m. It is possible to receive information from a neighboring detection node at ranges of up to 7000 m. Other communication systems allow the detection node to be integrated with higher command post and receive from it the required information about the air situation. In 1984, Saudi Arabia entered into a contract with Thomson-CSF to create a modernized version of the Shahine-1 complex, called Shahine-2. The

contract value was 4 million US dollars. This complex was supposed to be mounted on an AMX-30 chassis or a towed trailer. The latest version is called ATTS - Air Transportable Towed System. The modular design of the detection system and firing system allows them to be placed on any required platform. In the Shahine-2 complex, the range of the surveillance radar has increased to 19,500 m, there is SHADL (Shahine Data Link) communication equipment, which allows you to receive information from a control center of the Litton TSQ73 type. In addition, instead of an IR fuse, an electromagnetic contact is used

fuse.



Complex consisting of a self-propelled launcher and a self-propelled detection radar

In the period 1991-1993. Thomson-CSF completed a contract to upgrade several batteries of the Shahine-1 complex to the Shahine-2 level. The modernization program was named Dattier. The total contract value was US$492.7 million. In 1994, 670 million US dollars were spent on the repair of Shahine complexes and anti-aircraft systems.

Production of the Shahine complex has been completed. A total of 39 detection units and 73 firing units based on the AMX-30 chassis were produced, as well as 10 detection units and 19 firing units located on a towed trailer. It is in service with the Saudi Arabian Air Force and Air Defense. For a typical target having an effective surface and a speed

of 250 m/s (M0.75), below are

dispersion 1 m[2]

the following tactical and technical characteristics.

When a target moves with a non-zero parameter, the maximum destruction range is 8000 m, and the minimum destruction range is 2000 m. The probability of hitting a target with

one missile is 0.9,

and when using two missiles - 0.99.'

For the R460 rocket, the maneuvering capabilities are given below:

ness at different flight ranges. Flight range, m

maneuverability, g Flight time, s 6000 11 10 000 23 14 000* 45* - approximate data

35

15

8*

*

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km: maximum	
(depending on target type)	11.8
minimum	0.5
Damage height, km:	
maximum	6.8
minimum Mistral	0.01
missile length, m Missile	1.86
diameter, m Wingspan,	0.09
m Warhead mass, kg	0.2
Warhead type	3.0
	high-explosive fragmentation with contact and non-contact fuses

"Krotal-NG"

(FRANCE)

The Krotal-NG (New Generation) complex, developed in 1988, is designed to provide air defense for troops and civilian objects, combat formations of tank and mechanized brigades, and combat low-altitude targets. It differs from the previous version "Crotal" in greater accuracy in detecting and tracking targets, increased fire capabilities, and improved computing technology.

The Krotal-NG complex is unified (radar, missile defense) with the naval version Krotal-naval-NG. A modern all-weather complex can be divided into six subsystems, which can be mounted on various platforms, including even the M987 chassis from the American MLRS multiple launch rocket system. The electrically rotating tower of the Krotal-NG complex, weighing about 4800 kg, includes a surveillance radar with built-in

designated by the State Identification Requester, a dome-shaped tracking radar, optical equipment consisting of infrared, operating day and night,

measures, an infrared rangefinder, a daytime TV camera and eight combat-ready missiles, placed in two packages of four re rockets on each.

The Thomson-CSF TRS 2630 E-band surveillance radar with frequency tuning rotates at a speed of 40 rpm. It is equipped with a flat antenna and has improved noise immunity (low side lobes, beam gating, wide-band frequency switching and a constant level of false alarms), and is also capable of operating while the chassis is moving. The detection range for aircraft is 20,000 m and about 8,000 m for hovering helicopters. The maximum detection altitude is 5000 m.

it is possible to simultaneously auto-track eight, representing targets that pose the greatest threat. The

tracking radar is a frequency-agile monopulse Doppler station with improved noise immunity that operates in the J-band with a range of 30,000 m for targets such as hovering helicopters and aircraft with flight speeds above M2.

The optical-electronic target tracking system includes a Castrol thermal TV camera type thermal imager, which has a wide (8.Gx5.5°) and narrow (2.7°x1.8°) field of view (maximum range detection in good weather conditions is 19,000 m and decreases to 10,000 m in poor visibility conditions), a daytime television camera of the Mascot CCD TV camera type with a field of view of 2.4 °x 1.8 ° and a target detection range of up to 15,000 m, a video tracking channel of the tracking system for automatic tracking of the target and the missile, as well as an IR rangefinder with a wide field of view to capture the missile at the initial stage of its flight. The principle of missile guidance involves the use

data received by all measuring systems for transmission on board the rocket, where a microprocessor processes them. This improves the noise immunity of the data transmission process, and there is protection against the loss of one signal for a split second. After processing, missile guidance control commands are issued.

The rocket's flight is stabilized by four folding steel stabilizers that open after its departure.

from TPK. The warhead is of the TDA type - fragmentation type and directional action - triggered by an FPNG (Fulse de Proximity Nouvelle Generation) fuse. An electromagnetic contact-type fuse is triggered by a processor located on board the missile, with a delay time in the range of 0.2-0.5 s until the point of its meeting with the target. The radius of destruction of fragments is 8 m.

The maximum range of destruction of the missile is 11,000 m, and the minimum is 500 m. The height of the affected area is from several tens to 6000 m. The maximum speed of

the missile is M3.b. She reached-

It is powered by a solid-fuel rocket engine from the Sunwinder air-to-air missile, upgraded to reduce smoke signature. The missile flies to a range of 8000 m in 10 s and can maneuver with an overload of up to 35 g over the entire flight distance. The engine weighs 37.9 kg and contains 31.4 kg of fuel.

Under normal conditions, the radar and optical-electronic systems operate simultaneously and constantly monitor each other. Tracking systems determine the viewing area (observation window) where the target is located, the location of the guided missile and the location of decoys.

Within this viewing area, windows are calculated for each tracked target. The coordinates for each target obtained from various meters (radar channel and optical) are compared using a digital filter. In the future, a more accurate estimate of the coordinates of the target and the missile is used. All missile control commands are transmitted using a narrow beam (frequency tuning in the telecontrol channel is used).

Color monitor screens display target numbers in digital form; thermal and television images are transmitted to them, as well as video information from tracking radars, a large-scale grid of the surveillance radar and information about readiness to launch missiles. Operators can take advantage of the full capabilities of the computer menu displayed on the displays with

using the corresponding keys.

The process of detecting, capturing a target for tracking and destroying it occurs automatically. The shooter needs

It is possible to carry out state identification of the target only twice. The reaction time is 5 s. The total time required to detect a target and destroy it at the 8000 m mark is about 15 s. The re-acquisition time is 1-2 s and depends on whether the target is group or single. In theory

it is possible with one firing unit to destroy two separate groups of 4 targets each at the entire depth of the affected area from 11,000 m to 500 m. The reloading time of two missile packages is about 10 minutes.

The complex is in production. It is in service with France (Air Force - 12 air transportable container-type firing units), Finland (ground forces - 20 complexes on the SISU XA-180 (bkhb) ARS chassis, produced in 1992-1993). South Korea has several chassis purchased to modernize its own Pegas air defense system. In 1988, the Krotal-NG complex was adopted by the Finnish Armed Forces for its air defense system and occupied a

niche between the portable air defense systems Strela-2 (SA-7), Strela-3 (SA-14) , "Igla-1" (SA-16) and stationary computer

Южнокорейский вариант ЗРК

Lexom S-125 (SA-3). Initially, in 1992, 20 firing units with Thomson-CSF TRS 2630 radar were purchased and mounted on the SISU XA-180 (6x6) APCs chassis. Following Finland, the Royal Netherlands Air Force chose a container version of the Krotal-NG complex on a three-axle chassis to protect its air bases. However, financial problems affected the results of the program.

In mid-1991, the French Air Force became interested in the same version of the Crotal-NG complex. This version of the computer Lexa is attractive because she is an air transport Belnoy, thereby making it possible to carry out peacekeeping tasks anywhere on the earth. The French version provided for a combat crew of two people. The contract for the supply of 12 systems was signed by the French Air Force in 1997.

South Korea created its all-weather air defense system based on the Krotal-NG complex. In 1996, Thomson-CSF Airsys began work on placing the Krotal-NG complex on the Swedish chassis of the MO WAG Piranha (10x10), but there were no reports of the creation of a prototype.

The VT-1 missile, created for the Thomson-CSF and Krotal-NG complexes in mid-1986, underwent successful combat launches in 1989.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km: maximum	11.0
minimum	0.5
Damage height, km:	
maximum	6.0
minimum	0.02
Rocket length, m	2.29
Rocket diameter, m	0.16
Weight, kg:	
missile	75.0
warhead	14.0
Warhead type	High-explosive fragmentation with contact and non-contact fuses
Maximum missile speed, M	3.6
Reloading time, min	10
Engine	Solid propellant
Missile guidance method:	radio command

"Aspic"

(FRANCE)

The Aspic air defense system is designed to protect vital facilities and troop groups on the march. It works with automated target tracking radar and

has minimal reaction time.

The short-range air defense system (VSHORAD - very short range air defense) "Aspic" is a fully automated firing unit with surface-to-air missiles that engages targets in the near zone.

The tracking system, located on top, is integrated with an automated target tracking radar. She can mon-adaptable to different load-bearing chassis 1500 kg, including lightweight 4x4 chassis. In the latter case, four combat-ready missiles, located in transport and launch containers, are located on the launch pad

installation, and four more are in stock and located on the vehicle bed.

Depending on the type of missiles used, the number of combat-ready missiles located on the launcher can be increased to eight. The complex can use missiles such as “Mistral”, “Stinger”, “Starburst”, “Starstreak”, RBS-70 and

similar to them.

The chassis on which the equipment is located usually has a topographical reference and orientation system. The combat crew of the Aspic system usually consists of two people: the driver and one

The complex can use both Mk.l missiles and the later modification Mk.2, which is now the only one produced by Bofors both for the needs of its army and for export. The maximum engagement range of Mk.2 missiles is 7000 m, altitude - 4000 m.

The basis of the fire complex consists of two articulated tracked Bv 206 transporters. In the first control chassis the generator and communication equipment are on fire, receiving sharing information from the PS-90 surveillance radar. Moreover, information can be transmitted both via cable and radio link. The second chassis contains a crew of 3 people: the commander (he also doubles as the radar operator), the missile guidance operator and the long-range radar operator. The three-dimensional pulse-Doppler target detection radar PS-91 HARD (Helicopter and Aircraft Radar Detection) of the H/T band has a detection range of hovering helicopters of 8-10 km and aircraft - 16-20 km. The radar has a built-in “friend or foe” identification system. The radar includes a simulator for training operators, which has 60 raid scenarios pre-wired into memory. It has the ability to place 20 scenarios, which can be entered manually by the commander. The firing unit is capable of autonomously conducting combat operations, but to reduce reaction time it is interfaced with a 360-degree radar - PS-90 (Giraffe-75), which provides it with more accurate information. Joint combat operation of several RBS-90 systems is possible.

In this case, information is exchanged via communication lines.

The missile guidance operator is located in front of a display that reflects information from a television camera used to track a target designated by the commander in the daytime, and a thermal imaging camera to track a target by thermal radiation. The television camera has a viewing angle of 3x4°, and the thermal imaging camera has a viewing angle of 4x6°. The thermal imager operates in the wavelength range of 8-12 microns. The operator's task is to keep the target being fired at in the crosshairs. Information about the coordinates of the target is transmitted via cable to a twin launcher, which

raya is placed on the ground on a tripod. It also houses the equipment for transmitting missile control commands. When changing position, the launcher is folded and placed inside the tractor. The transport chassis contains missiles in transport and launch containers, as well as the necessary spare equipment, and there is room for five people. A missile with a high-explosive fragmentation warhead is guided by a laser beam.

SAM in stowed position (PS-91 HARD radar is located in the second trailer)

TACTICAL AND TECHNICAL CHARACTERISTICS OF THE MK..2 ROCKET

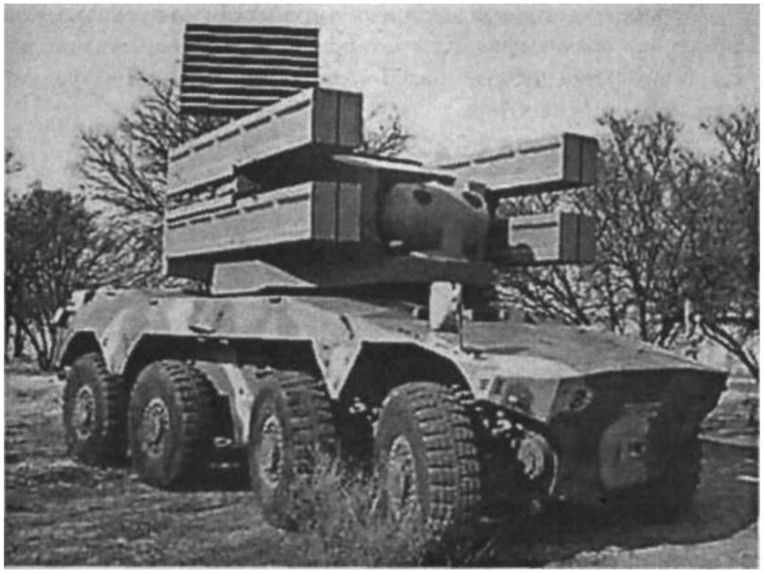
Damage range, km:	
maximum	7.0
minimum	0.2
Damage height, km:	
maximum	4.0
minimum	0.01—0.02
Length, m:	
rockets	1.31
rockets in TPK	1.74
Wingspan, m Weight, kg:	0.68
rockets	
rockets in	10.1
TPK Maximum	26.5
rocket speed, m/s Collapse time, min: during the day	580
	5
at night	8
Deployment time, min Reaction time, s	10
	6

TACTICAL AND TECHNICAL CHARACTERISTICS of the PS-90 radar

Detection range, km:	
maximum	75
minimum	
Combat crew, people	1
Number of measured coordinates Viewing angle,	
deg. Range of measured speeds,	2 3 0—
m/s Review speed, rpm. Average output power, W	35 5—
Peak output power, W	
	500 40 8 65

"ZA-HVM"

(SOUTH AFRICA)



The ZA-HVM missile system is designed to destroy aircraft and helicopters flying at low and extreme but at low altitudes, at ranges up to 10 km.

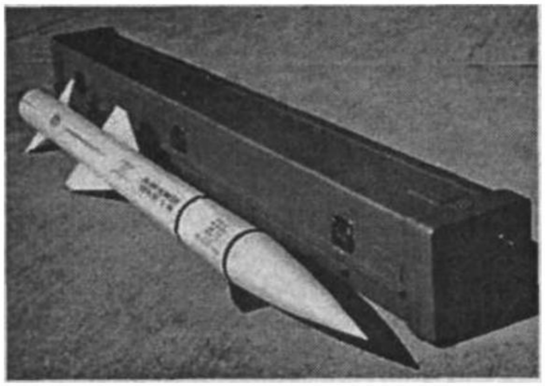
The complex was created on the basis of a twin 35-mm anti-aircraft artillery Lerian installation ZA-35.

The complex is equipped with ESP software guidance radar, which allows it to detect air targets at ranges of up to 25 km and at altitudes of up to 7.5 km. The optical sight used in the anti-aircraft artillery mount has been replaced with a new tracking system - IORT (Integrated Optical Radar Tracker).

The ESP 110 radar operates in the K-band wavelengths. The air defense system is equipped with a TV and IR camera; they are used to track targets and missiles in the optical mode of combat operation.

The ZA-HVM complex uses SAHV-3 missiles, creating given for the modernized version of the Krotal air defense system. This missile is equipped with a combined receiver that allows it to receive guidance commands both from a radar ESP software and optical system. All this allows wholesale

optimize combat operation modes in any conditions of combat operations (in complex jamming environments, in conditions of poor visibility, etc.). Four missiles, located in transport and launch containers, are placed on a quad launcher. A more multi-axle chassis can simultaneously accommodate 8 combat-ready missiles.



TACTICAL AND TECHNICAL CHARACTERISTICS

Target engagement range, km:	
maximum	12.0
minimum	0.8
Damage height, km:	
maximum	7.5
minimum:	
aircraft	0.03
helicopters	0.005
Missile parameters, m:	
length	3.13
diameter	0.18
wingspan Weight,	0.4
kg: missiles	
missiles	115.0
in TPK	165.0
Maximum speed, M Flight time,	3.5
s: at a range of 12	
km at a range of 8 km	17.0
at a range of 6 km at	10.0
a range of 4 km	4.9
Reloading time, min	3.0
	8 (4 missiles)

"Pegasus"

(SOUTH KOREA, **FRANCE)**

Production of individual components of the Pegasus air defense system began in 1996 in South Korea. Go-
The leading executor of this project is a special division of the South Korean corporation Daewoo.

The complex is designed for air defense of mechanized units of the South Korean army both on the battlefield and during the march. The tracked chassis used for the new complex is the latest version of a number of chassis models created by the Daewoo Corporation for the South Korean army. The new all-wheel drive tracked chassis used in the Pegasus complex is longer than the previous one.

existing versions, including a chassis on which a 30-mm twin anti-aircraft gun of the Flying Tiger type is placed. At the beginning of 1996, two prototypes of the Pegasus complex were created, but the tests were not carried out in full. There has not yet been an order for mass production. The chassis of the Pegasus complex is armored to protect the crew from shell fragments and bullets. The driver is with

left side. A 520 hp diesel engine is installed in the front of the chassis on the right side. with an automatic transmission, which allows the chassis to reach speeds of up to 60 km/h. Acceleration from standstill to 32 km/h occurs in 10 seconds.

The total weight of the chassis with weapons, according to experts, is about 25 tons. The chassis is additionally equipped with an auxiliary 43-horsepower engine, as well as a standard set of equipment, including filter and ventilation.
nuclear installation to protect the crew during radioactive
contamination of the area, a chassis fire warning system and a smoke system for setting up a smoke screen. The equipment of the launch
complex is mounted on top of the chassis, which has 4 missiles in transport and launch containers on each side of the chassis. In the center there is radar equipment as part of an S-band pulse-Doppler surveillance radar with a target detection range of up to 20 km. The surveillance radar allows you to detect and track up to 8 targets.

The pulse-Doppler tracking radar mounted below the surveillance radar operates in the Ku-band wavelengths and has a range of 16 km. It is designed to accompany hovering helicopters and other targets with a maximum speed of up to M2. Both radars perform instantaneous frequency tuning from pulse to pulse. To the left of the
tracking radar is the equipment of the FLIR (Forward Looking Infra-Red) thermal imaging system with a detection range of up to 15 km, on the right is a TV camera with an IR goniometer, operating during daylight hours with a detection range of up to 10 km. The IR goniometer is used for the initial detection and capture of a launched missile and has a field of view of 10°.

According to Daewoo Corporation, the Pegasus complex can destroy targets day and night in a complex jamming environment. The launch complex
equipment and detection equipment, similar to that used in the Crotale-NG complex, are supplied by the French company Thomson-CSF Airsys.

The rocket used in the Pegasus complex was created

by a South Korean company independently and differs from the Crotale-NG missile. It is located in a sealed
container, equipped with a laser proximity fuse and a 12-kg directed-action fragmentation warhead, which provides a high probability of hitting air targets.

The maximum speed of the missile is M2.6, the maximum effective destruction range is 10 km with the possibility of performing a maneuver with an overload of up to 30 g at the far border of the affected area. The rocket has 4 wings in the nose and 4 rudders in the tail of the body.

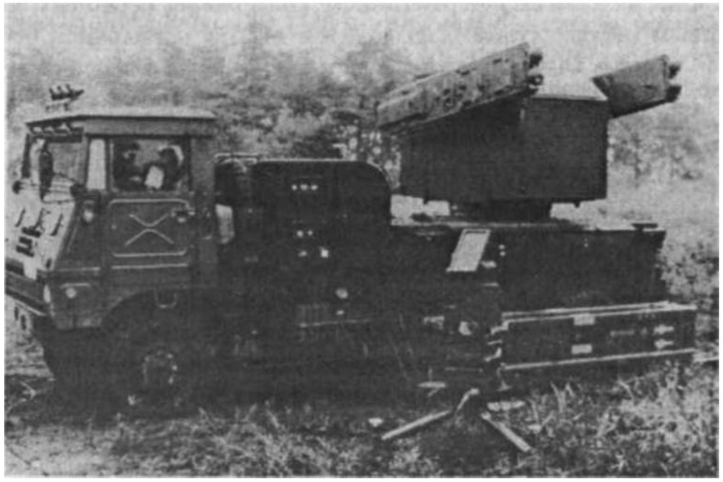
The missile command guidance method is used, but the maximum range for hitting targets is still lower than in the Crotale-NG complex.

When all missiles are used up, reloading is carried out
is done manually by the crew.
The missile guidance operator has a multi-screen panel with color monitors. Computing software
The physical means of the complex allow you to integrate the Pegasus complex into any air defense system. Currently
the complex has not yet been adopted for service.

TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km: maximum	11.0
minimum	0.5
Damage height, km:	
maximum	6.0
minimum	0.02
Rocket length, m	2.29
Rocket diameter, m	0.16
Weight, kg:	
missile	75.0
warhead Warhead	14.0
type	High-explosive fragmentation with contact and non-contact fuses
Maximum missile speed, M 3.6 Reloading time, min 10 Engine	solid propellant
Missile guidance method	radio command

"Tan-SAM" (JAPAN)



The Tan-SAM complex is designed for air defense of the country's most important facilities, as well as military airfields, naval bases, etc.

The tactical and technical specifications for the development and creation of the Tan-SAM air defense system (in Japanese Tan means close) were formulated by the command of the Japanese Ground Self-Defense Force (JGSDF) in 1966 with the aim of replacing M15A1 anti-aircraft guns of 37/12.7 mm caliber and stationary 75 mm M51 guns were in service. Research and creation of prototypes of individual systems of the complex were completed in 1969. In the first half of the 70s, tests of all systems of the complex were carried out.

lexa separately, and successful tests of the complex as a whole were completed in 1978-1979, which allowed the JGSDF command to accept the Tan-SAM complex for service in 1980 and assign it the code Toure 81 - short-range air defense missile system .

In accordance with the rearmament plans of the JGSDF command, each division was to have four Tan-SAM complexes. The first complexes were located in the north

noi part of the island of Hokkaido. The complex includes a fire control unit located on the chassis, two launchers on the chassis (each with four missiles), as well as several chassis with supporting equipment. The total number of personnel of the complex was 15 people.

In the mid-70s, the command of the Japanese Air Self-Defense Force (JASDF) began to work to increase the survivability of its air bases. The work was carried out both in terms of building up active defense means and through the implementation of organizational measures. The Tan-SAM complex was chosen by the JASDF command to provide air defense to air bases at distant borders. If enemy aircraft break through the long-range air defense line, they are met at close approaches by the fire of batteries of Stinger MANPADS and 20-mm M167 Vulcan anti-aircraft guns, the latter being produced in Japan under license.

The JASDF command created six air defense battalions of mixed composition, along with the Tan-SAM complex and the Stinger MANPADS, they included the Patriot complexes.

In the Japanese military budgets for 1990, 1991, 1992, funds were allocated for the annual purchase of two Tan-SAM complexes for the needs of air defense forces at naval bases.

The Tan-SAM missile is a single-stage missile that operates on a fire-and-forget basis and has four movable tail wings. The rocket is equipped with a solid fuel engine, its exhaust is white, which allows you to visually observe the launch, as well as the flight

missiles to target.

The guidance system uses the autopilot during the initial phase of the flight, and then switches to the IR seeker, which is located in the nose of the rocket body. Before

by start, the declination angle value is programmed by calculation means of the combat control cabin, taking into account preventing launch in the direction of the sun.

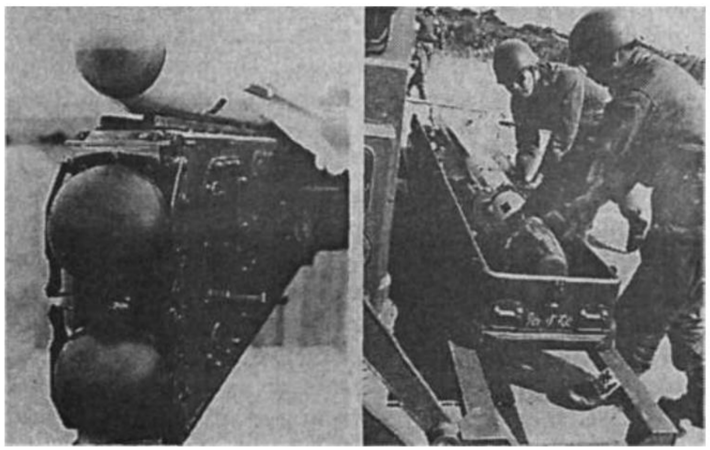
After the missile launches and reaches the point where the IR seeker is turned on, a given area of space is scanned in order to find a target in it. Guidance system

While the IR seeker is in motion, it locks onto the target for auto-tracking, and the missile continues to fly to the intended meeting point. When approaching the target, either a contact or non-contact fuse is triggered, and the fragmentation warhead is detonated. The damaging radius of dispersion of warhead fragments ranges from 5 to 15 m, depending on the type of target. Self-destruction of the missile in case of a large miss is not provided. Although adverse weather conditions affect the performance of

a combat mission, the operation of the Tan-SAM complex can be compared with the operation of the Roland complex in similar weather conditions. The parameters of the affected area remain unchanged. It should be noted that the missile does not have IR filters installed, which allows targets firing IR traps or maneuvering against the background of the sun to avoid being hit by the Tan-SAM missile.

When conducting combat work against targets flying at pre-
at low altitudes in conditions of strong electronic counteraction from the enemy, as well as from directions where there is a failure in the radar antenna pattern, missile guidance can be transferred to the optical channel. An optical sight is placed on each launcher.

The combat crew of the complex consists of a commander, a radar operator and two launcher operators. Each chassis of the complex is leveled using hydraulic



Loading the launcher is done manually

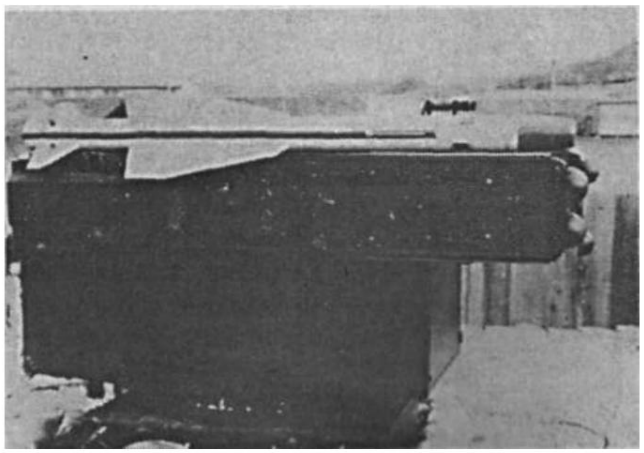
support Communication between the various chassis of the complex is carried out either via cable or radio link. The usual distance between the combat control point and the launchers is up to 300 m. The total deployment time of the complex to a new position is 30 minutes.

After the deployment is completed, the surveillance radar, located at the combat control point, begins scanning the airspace. When a single target is detected, the process of combat work is simple, but in the event of a group target being detected, the combat crew needs to determine the priority of each target from the group. When a priority target enters the launch zone of the complex, the light indication at the combat control point lights up and preparation begins

rockets for launch.

The guidance system allows you to simultaneously aim two missiles at a target, or aim one missile and, assessing the results of its firing, make a decision to fire again. Thus, it is theoretically possible to destroy up to four targets using missiles placed on one launcher. Given that the probability of hitting a target with one missile is 0.75, it is unlikely that four missiles will destroy four targets.

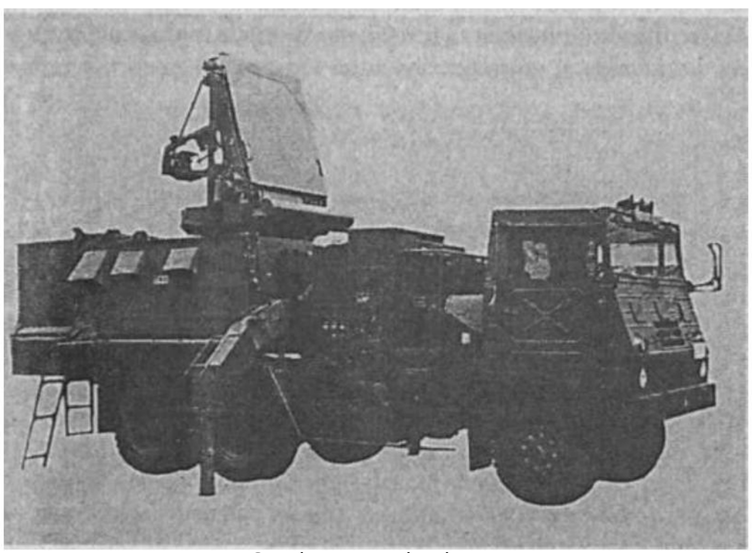
If necessary, a combat control point, two launch
high installations and corresponding power supplies



The PU can be dismantled and installed on the ground

can be removed from their chassis and used either stationary, or redeployed to any necessary point in the area using U-107P-4D1A-4 or CH-47J Chinook helicopters at a distance of up to 100 km. The total weight of the combat control point is 3054 kg, it is

mounted on a modified Tour 73 wheeled chassis (bkhb), the chassis weight is about 3000 kg. It includes a 30 kW generator, which is located in the rear of the chassis, and a cabin with equipment located on top of the chassis. A phased antenna array of a pulse-Doppler radar is placed on the roof of the cabin (the size of the antenna panel is about 1 m wide and 1.2 m high), and mechanically rotates in azimuth. The combat control point chassis is leveled using three hydraulic supports (outriggers). The cabin is not armored, and there is no filter for ventilation equipment designed to protect the crew. The radar detection range is 30 km, and there is a system for determining the nationality of the target. The rotation speed of the phased antenna is 10 rpm. In one revolution, a region of space is viewed in elevation from 0 to 15°, and in azimuth - circularly. At


Combat control point

the purpose of the sector view mode of the space phased array radar scans in azimuth - any 110o , 00 elevation angle - from 0 to

20°. The computer complex of the combat control point assigns an individual number to each detected target. Target tracks with their numbers are displayed on three
displays in the form of target number, range, altitude and flight direction. The crew commander assigns priority to targets and points the radar operator to the targets that will be fired upon. The radar operator uses a cursor to mark selected targets, thereby ensuring a more

accurate radar tracking of the routes of these targets. In total, up to six targets can be selected for this (precise) tracking mode. Each of them is displayed on the display screen together with the values of its coordinates; the information update rate is 1 s.

Information about the coordinates of the two tracked targets at which the missiles will be launched is sent to the selected guidance system with the help of the computational means of the combat control point, which also generates commands for the appropriate rotation of the launchers in the direction of the target intended to be fired. When the target is in the launch zone, the rocket (missile) is launched from the launchers.

The launcher with the power equipment placed on it weighs approximately the same as the combat control point, and is mounted on a similar chassis. It is also not armored, but has four hydraulic supports.

ry for leveling.

Each missile is loaded onto the launcher using a hydraulic loading platform, there are
two, they are located on opposite sides of the chassis. The missile, which is in a transport container, is hand-
The missile is removed from it and placed on the loading platform by the combat crew, then the missile is loaded into its place on the launcher. To fully load, this process is repeated four times; the total time for loading the launcher with a prepared crew is about 3 minutes.

Currently, there is a modernized version of the Tan-SAM complex, which is called Tan-SAM-kai (kai is a symbol of modernization in Japanese). In 1983, a modernization program for the complex was supposed to begin, but for financial reasons it was postponed for six years and completed in 1994. The essence of the modernization is the creation of an active radar homing head for the missile, replacing the rocket engine with a new one that increases speed missiles and the far border of the affected area (up to

14 km). In the area of missile guidance to the target, a command radio line is organized,

allowing the missile's flight to be adjusted in accordance with the maneuver of the target being destroyed. In addition, at the combat point control, a thermal imager is installed, thereby increasing the combat effectiveness of the complex increases in conditions of strong of electronic jamming.

Production of the Tan-SAM complex has been completed. As of 1995, about 1,800 missiles were fired. In total, there are *57* complexes in service with the Air Defense Command of the Japanese Armed Forces , the Air Defense Command of the Japanese Air Force - 30, and the Air Defense Command of the Japanese Navy - 6.

The Tan-SAM-kai complex is mass-produced. There is no information about the export of the complex.

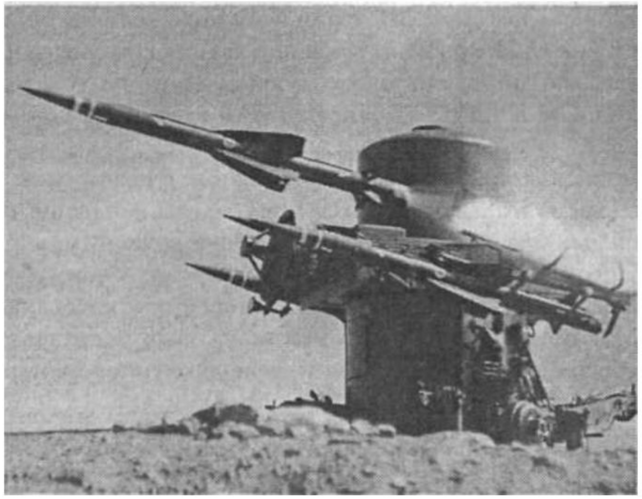
TACTICAL AND TECHNICAL CHARACTERISTICS

Damage range, km:	
maximum	7.0
minimum	0.5
Damage height, km:	
maximum	3.0
minimum	0.015
Rocket length, m Rocket	2.7
diameter, m Rocket	0.16
wingspan, m Rocket mass, kg	0.6
Maximum rocket speed,	100.0
M Warhead type	2.4
	high-explosive fragmentation type with contact and proximity fuses Guidance system
reprogrammable autopilot with passive infrared homing during the final flight phase	

STATIONARY ANTI -AIRMISSILE SYSTEMS

"Rapier"

(GREAT BRITAIN)



The Rapier complex is designed to destroy air targets at low altitudes in the near zone. It began to be created in the early 60s by order of the British Ministry of Defense and replaced the 40-mm L/70 Bofors anti-aircraft gun.

It was supposed to create a complex with a short reaction time, the ability to quickly take a combat position and leave it after completing a combat mission, with a compact placement of equipment and small weight-dimensional characteristics, a high rate of fire and a good probability of hitting a target with one missile. In addition, the latter must have a large affected area with the ability to destroy targets with speeds up to Ml.5 in the altitude range from minimum to 3000 m.

The official name of the Rapier complex appeared in 1967, although the creation began in 1963, and the first unguided missile launches took place in 1965. In April 1967, the first successful firing

was carried out with the missile aimed at the target, flying at an altitude of 914 m, and its destruction at a distance of 3048 m.

In the UK air defense system, the Rapier complex was used in the second and third lines of air defense. The first consists of portable air defense systems of the Javelin and Starburst types, which created a kill zone in the so-called “dead crater” of the kill zone of the Rapier complex. The second line of air defense was created by a self-propelled, and the third by a towed version of the Rapier complex.

According to British experts, towed and self-propelled systems are used to perform one of the main tasks of air defense - covering a large area of combat operations, as well as the defense of vital centers and all-round air defense of the main forces of the army or military units performing a march. Typically, air defense of troops is carried out to a depth of 30 km.

The two complexes are usually located at a distance from each other. when their mutual cover is carried out, the rest These complexes can be located at a distance of 1-2 km from each other along the route of the troops' march. .

The battery commander and his communications officer receive all the necessary information using the battery's computing facilities, namely: the coordinates of the 12 best firing positions are selected, as well as several reserve positions, taking into account the combat missions facing the battery and the available radar support. After the end of combat work, the complexes (firing units) can change their firing position. For the Rapier self-propelled systems, all of the above three main air defense tasks

can be assigned. It should be taken into account that increased maneuverability allows the complex commander to choose an individual fire

position in the event that the old position has become unusable noah for combat operations. To protect tank units on the battlefield, the positions of the Rapier complex should be located several kilometers behind their combat

order.

The complex consists of semi-trailers on which the optical system and combat-ready missiles are located

missiles (with power supply), air target detection radar "Blindfire" (with power supply), ammunition of 8 missiles. All semi-trailers are towed by off-road vehicles such as Land Rover.

Each battery of firing units has a communications point and a repair unit with diagnostic and spare equipment. In addition, there are two spare battery semi-trailers, for

one contains the optical station, the other contains the rest new main spare electronic elements of the complex.

The Rapier complex was constantly modernized, both tactical and technical characteristics were improved, and the possibility of destroying new types of targets (for example, cruise missiles) appeared. In general, it is believed that the degree of automation of the complex's combat operations increased by 50% by the end of 1987. The modernization program concerned both existing and newly mass-produced complexes. By 1997, there were more than 700 firing units of

both towed and self-propelled versions of the Rapier complex and 25,000 missiles of various modifications. In addition, about 12,000 missiles were expended during the past period during tests, exercises and combat operations. Individual elements of the Rapier complex can be transported by SA 330 Puma or CH-47 Chinook helicopters. The C-130 Hercules transport aircraft can accommodate one complex with the Blindfire radar or two semi-trailers with an optical system and all-terrain vehicles. When exporting the complex, the specific requirements of each country that purchased the system were taken into account. For identification purposes, an index system is used. The basic Rapier complex with the Blindfire radar has the code “Field Standard A” (FS A). In 1979-1980 followed by the “Field Standard Bl” (FS B1): the main element of the modernization was that the target detection radar would automatically turn off when a launch of an anti-radar missile was detected. In addition, the friend-foe identification

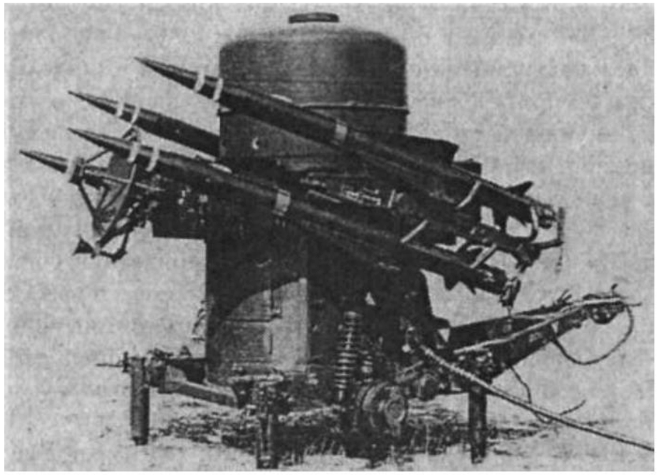
system has been improved, and the complex has become more noise-resistant in conditions of radio countermeasures. In 1994, the TDU was developed. It has two displays, one of which displays primary information

tion, on the other - secondary. The TDU unit is remote, carried by two combat crew members. Information is exchanged via communication lines. It is believed that this increases the security and survivability of the combat crew.

In 1985, an optical-electronic system of the FS B2 standard, called "Rapier Darkfire," passed military tests. The optical system includes a thermal imaging device, a launcher with six missiles and an improved flat pulse-Doppler surveillance radar array. In addition, a TCS (Console Tactical Control system) panel appeared for the fire unit commander. 4 batteries of the Rapier complexes of the FS B2 standard were produced. All these modernizations were taken into account when creating the computer

lexa "Rapier 2000".

The main component of the Rapier towed complex is a launcher located on a semi-trailer. At the firing position, the wheels of the semi-trailer are blocked, the semi-trailer is stabilized by four adjustable supports. The optical device has a tilt angle from -3° to +60° in elevation and all around in azimuth. The surveillance radar (range - 15 km, height - up to 3 km) is located in the middle of the launcher, the antenna is under the radome and rotates at a speed of 1 rpm.



Launcher

The surveillance radar, together with the friend-foe identification system, provides detection and warning of approaching aircraft and helicopters. The launcher has two missiles on guides on each side. The missile guidance command transmitter is located

between the missile guides.

The optical system is located on a tripod, each leg of which is adjustable and consists of a fixed and rotating head part. The tilt angle in elevation ranges from -10° to +60°, which is ensured by the mobility of the prisms of the rotating head part. There are two types of field of view of space. The wide field of view is 20° and the narrow field of view is 4.8°. The operation of the optical system is controlled using

computer with the possibility of operator intervention to move to a narrow field of view of the space.

Target tracking by the optical system is not automated; the operator uses a joystick to track the target. At the same time, the missile guidance system is fully automated. A TV system is used that captures the missile after launch in a wide field of view of 11°, and then automatically switches to a field of view of 0.55° when pressed.

guiding the missile to the target.

The operator is provided with a biocular sight for resistance
driving the target and must accompany it during the flight of the missile. The TCU (Tactical Control Unit) unit provides the ability to tactically control combat work. It is connected by cable to the launcher and optical system, and is divided into 32 sectors in the azimuthal plane (each sector is 11°25' wide). Ensuring that any

sector, the operator thereby creates a corridor for the passage
your goals. The illumination of any sector indicates the priority of the direction of fire - the designation of the primary firing sector.

The Mk.I rocket is made according to a normal aerodynamic design and consists of four main sections - the warhead,
guidance, engine and control systems.

The 1.4 kg warhead is semi-armor-piercing and contains 0.4 kg of explosive, safety and actuating mechanisms, and a contact fuse. Folding plate

The stick fairing provides an optimal aerodynamic shape. The guidance section consists of electronic and mechanical parts.

The dual-mode single-stage engine provides the rocket with a maximum speed of about 650 m/s. The control section has a mechanism for controlling the rudders, powered by a gas jet, changing their position and thereby controlling the flight of the rocket. At the rear there are 4 tracers designed to capture the missile with the TV system and accompany it.

The missile can use both optical and radar guidance modes. Maximum time The name of the missile flight to the far border of the affected area is is 13 s, and the minimum is about 3 s. The probability of hitting a single target is 0.7.

The missile arrives to the troops fully equipped, combat-ready and does not require inspections if stored in proper conditions. When stored in warehouse conditions, the service life is 10 years.

In 1988, the Mk.lE missile, designed to combat remotely piloted aircraft, was tested. This missile uses a similar rocket engine and a modernized “smart” IR contact fuse with a directed high-explosive fragmentation warhead. It is envisaged that the new missile will replace the ML1A missile, however, it is also planned to modernize the Mk.lA in order to give it the ability to destroy small air targets. Serial production of the Mk.lE missile began in 1989. In the early 90s, the Mk.2 missile was created, which can be used in all versions of the Rapira complex, including self-propelled and towed versions, as well as the new generation Rapier 2000 complex " In mid-1992, it was announced that a contract had been signed to modernize all Rapier towed systems in service with both the British Army air defense system and the Royal Air Force, with the aim of using the Mk.2 missile in them. To achieve this, it was planned to modernize the computer software.

body systems, tracking radar and TCU unit. The program began to be implemented in 1995.

The Mk.2 missile with a launch weight of 43 kg exists in two modifications and has an increased destruction range by 15-20%. The Mk.2A modification is equipped with the same semi-armor-piercing warhead as its predecessor. Mk.2V has a combined high-explosive fragmentation and armor-piercing warhead with two types of fuse: contact delayed action and remote.

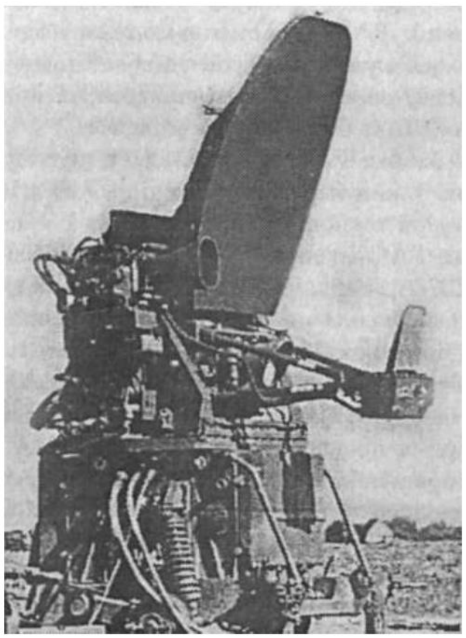
Thomson Horn Electronics produced a trial batch of IR fuses for the MK.2A missile in 1990. Full-scale production of the fuse began in mid-1991. Detonation of the fuse is provided by four receiving devices, working in conjunction with a special processor that calculates the most optimal point triggering the fuse and detonating the warhead to destroy the target.

The DN 181 “Blindfire” radar with a range of 10 km was created by Marconi to ensure the operation of the Rapier complex at night and regardless of weather conditions. The frequency-modulated signal radar was designed taking into account dimensional limitations and with a mass capable of being placed on a semi-trailer and adapting to any type of complex. In combat operation, the radar tracks the target and the missile, using a very narrow pencil-type beam in order to achieve the required tracking and guidance accuracy. The first radar prototype was created in 1970. Serial production began in 1973, the first samples were used by the Iranian armed forces. The radar entered service with the British Ministry of Defense in 1979. The Blind-Fire radar was successfully tested together with the American Chaparral air defense system. By 1997, more than 350 radars had been produced. Production has now been completed. When deployed at the firing position, the radar is horizontalized using four adjustable supports. The main components of the radar are: electronic equipment, transceiver system and hydraulic equipment. On top is the main antenna canvas and the missile guidance system transceiver and optical TV guidance system.

Attaching the Blindfire radar to the Rapier complex allows you to successfully destroy targets in night conditions and poor visibility. The goal tracking process is automated van, which ultimately reduced reaction time, increased the probability of hitting a target, reduced the number of manual operations. As soon as

the surveillance radar detects a target, the coordinates of its azimuthal direction are sent to the Blind-Fire radar and it turns with the main antenna blade opening in the direction of target detection. There is a quick scan of the area of space where the target is expected to be found and captured for tracking. Thanks to this, the target coordinates are received with greater accuracy.

At this time, the operator is informed with the help of an audio signal sent to the head phones about the detection and acquisition of an alien target for tracking. When entering When the target enters the affected area, the indicator light lights up, indicating the number of missiles ready for launch. Those-



Radar "Blindfire"

The operator must first press the “Start” button to start that rockets.

After launch, the missile is automatically captured for tracking by the Blindfire radar. Signals are generated for eliminating the deviation of the missile from the target line of sight, which are automatically transmitted on board. The Blindfire radar is connected via a cable to the launcher.

The operator can switch to optical guidance of the missile at any time during its flight to the target. The mobile optical firing unit is towed by two Land Rover vehicles and consists of two semi-trailers, one of which houses an optical radar and 4 combat-ready missiles on guides. The missiles are transported in their own transport containers, and there is an energy source on the semi-trailer. The second semi-trailer carries 8 spare missiles in transport containers, as well as spare equipment for an optical radar and a power supply. The time for collapsing and deploying the system is 20 minutes, this work is carried out by a combat crew of three people. When conducting prolonged hostilities (more than a day), five people are needed. The Rapier complex can be integrated into the overall air defense system.

The optical firing unit is converted into a Blindfire firing unit by adding to the first Blindfire radar, towed by a third vehicle, which also carries 4 missiles located in transport containers. The semi-trailer where the Blindfire radar is located has its own power source.

Thus, the Blindfire mobile firing unit consists of 3 light all-terrain vehicles, 3 semi-trailers with a total ammunition capacity of 17 missiles. In terms of combat capabilities, the Blindfire firing unit has its own surveillance radar, a “friend or foe” identification system, a target and missile tracking radar, operating in all weather conditions and around the clock, ready for immediate use and in ammunition storage rockets, power supplies. This firing unit can conduct combat operations autonomously or be integrated into the air defense system by using appropriate communication lines.

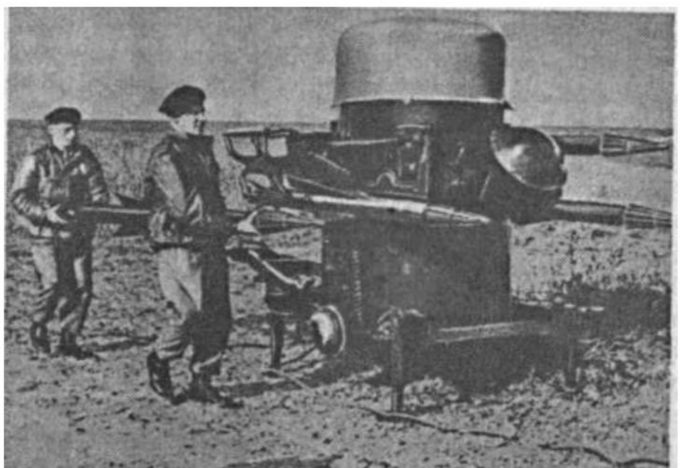
The combat operation of the Rapier complex occurs as follows. The surveillance radar, constantly rotating in a circle, detects targets (airplanes and helicopters) falling within the viewing area. When a target is detected, it is automatically identified. If the target is not your own aircraft, then an alarm signal is sent to the operator's headphone. At the same time, the optical and radar systems are automatically rotated in the direction of the target. Radar tracking acquisition begins by viewing the area of space where the target is located. Radar tracking continues until the operator switches to manual tracking with the optical system. Radar method of target tracking

is the main one, and in case of interference or for other reasons-
We can perform manual tracking by switching to the joystick and working with the optical system. In this case, visual identification of the target by the operator is possible.

Information from the optical system and surveillance radar is sent to a computer located on the launcher, and this information is used to calculate the moment

and the coordinates of the target hitting the affected area.

When a target enters the affected area, a visual signal (light) lights up in the field of view of the operator, who



Заряжание пусковой установки

should immediately press the "Start" button. The missile launches and is aimed at the target without the intervention of the combat crew. During a rocket flight, the operator performs only one

task - accompanies the goal.

The missile has a semi-armored warhead. A blast wave of great force produces destruction inside the target. Such destruction of a target by a missile from the Rapier complex was called a "penetration system."

After hitting a target, the operator can immediately switch to the space survey mode *to* capture and destroy the next target, or launch a second missile at the same target or another one located in the operator's field of view.

Reloading four missiles by a trained combat crew is carried out in less than 2.5 minutes. The surveillance radar is capable of detecting low-flying targets against the background of signal reflections from the earth's surface at ranges of more than 15 km. The missile hitting a target on the far border of the affected area is 7000 m, thereby the area of the affected area is 150 km^2 for one complex (fire unit). The reaction time of the complex (the time from the moment of target detection to the missile launch) is about 6 s, which has been repeatedly confirmed by live firing. In the British Army, elements of the Rapier complex are usually towed using a one-ton all-terrain vehicle (4x4 wheel arrangement) Land Rover.

Following trials in 1990, the Royal Air Force placed an order for a replacement 214 tug-

Launcher in transport position

new Land Rover cars with a new 8-cylinder power of 127 hp. engine.

For customers in the Middle East, the SUPACAT all-terrain vehicle (6x6 wheel arrangement) was used as a tractor. The Rapier complex can currently be produced according to a specific order. It has been widely exported to many countries around the world. The largest buyers: Australia, Indonesia and Switzerland.

The Rapier complexes participated in the 12th British Air Defense Regiment during the Falklands conflict of 1982. 12 launchers were deployed, and the complexes participated in combat operations from the very first day of the landing on the Falkland Islands. Sources of the British government (White Book: Falklands Campaign. Lessons) claim that 14 Argentine aircraft were destroyed by Rapier complexes. However, according to other information, the Rapier complex shot down only one AI Dogger A aircraft and participated in the destruction of the A-4C Skyhawk aircraft. It is alleged that the Blindfire RAS did not take part in these hostilities.

The Rapier complex participated on the side of Iranian forces in the war between Iran and Iraq in the 70s, and is believed to have destroyed an Iraqi Tu-22 bomber.

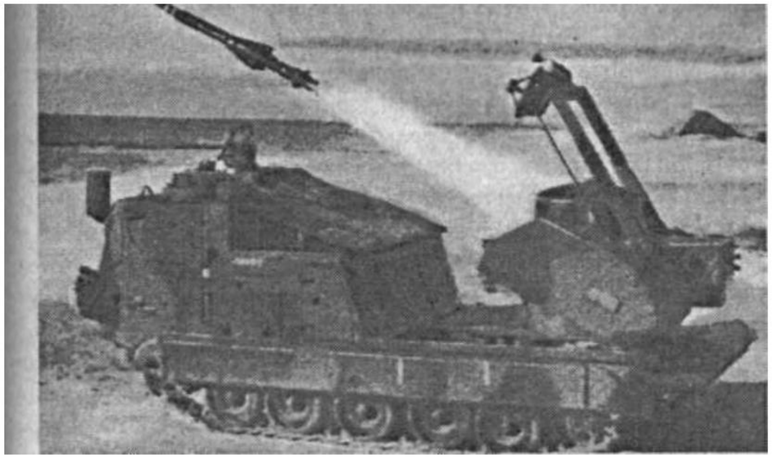
TACTICAL AND TECHNICAL CHARACTERISTICS OF THE MK.1 ROCKET

Length, m	2.24
Diameter, m	0.13
Wingspan, m Launch	0.38
weight, kg Maximum	42.6
speed, M Far border of the	over 2.0
affected area, km Near border of the	7.0
affected area, km Maximum height of the	0.25
affected area, km	over 3.0

"Rapier"

(self-propelled version)

(GREAT BRITAIN)



The Rapira air defense system in its self-propelled version is designed to engage air targets at ranges of 0.5–7 km and altitudes from 30 to 3600 m.

The creation of the Rapier self-propelled complex began in 1974 by the Guided Weapons Division of the British Aircraft Corporation. The M548 tracked transporter, a prototype from the M113 family, which is in service in more than 40 countries around the world, was chosen as the chassis. Serial production began in

1978, the first complexes began to enter service in 1983. The self-propelled chassis of the Rapier complex (TRLV -

Tracker Rapier Launch Vehicle) received the code RCM 748. The crew of three is located in an armored cabin that protects the crew from shell fragments and bullet hits. The driver is on the left side, the commander is in the center, and the operator is on the right. There is a door on each side of the cab and bulletproof glass on the front and sides. Both the driver and the commander can, if necessary, use night vision devices and fire extinguishing equipment. The hatch is intended for the commander.

In the absence of radar information, the commander can visually detect the target and, according to a certain operating algorithm, lock on the target for auto tracking, using the standard GEC optical system - Marconi Helmet Pointer System. The commander's workplace is equipped with a TCU (Tactical Control Unit - selection of the firing sector), equipment for functional control and radio communications. All equipment is vibration-resistant.

The firing sector selection unit provides control of the tactical situation; it is connected to the launcher and optical system. There are 32 sectors in azimuth, the sector size is 11°25'. Any sector can be assigned priority, thereby ensuring priority fire at a target flying from a given priority direction. Safe overflight zones may be established for their purposes. Combat work at any time of the day is ensured with the help of additional equipment, including a thermal imager with a range of up to 10 km with the necessary electronic equipment and an air cooling system. All equipment is mounted on a rotating chassis platform. The operator himself can choose the operating mode - optical or thermal imaging. The tracking radar is designated TOTE (Tracker, Optical Thermally Enhanced - tracking system, thermal imaging amplifier). She

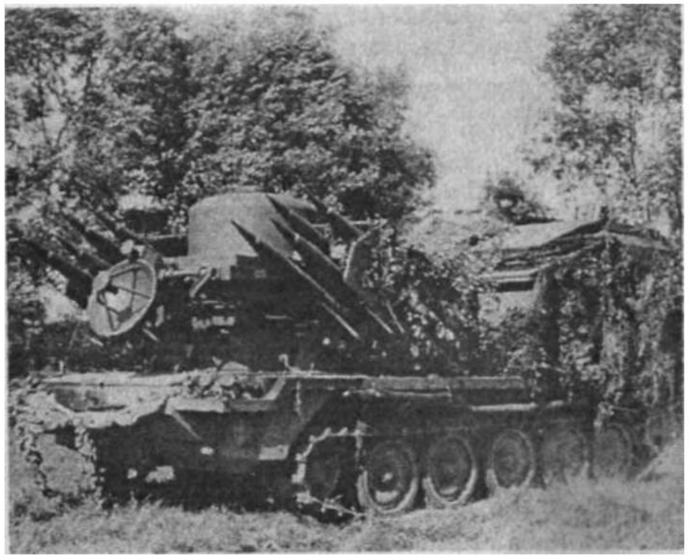
can be additionally programmed for automatic mode
tical passive work in addition to the main task of round-the-clock target detection. The TOTE tracking system is mounted on an anti-vibration platform on the right side of the cabin. When deployed, it rises to the working position, and after completion it folds and retracts. When folded, it is protected by an armored flap.

The operator locks onto a target for tracking using an optical or thermal imaging channel, aligning the target mark with the joystick mark. Optical and tracking systems

used to capture a missile and bring it into line
sighting, then its deviation from the line of sight is assessed
control commands are generated and transmitted to the rocket for the purpose of correcting the flight to the meeting point.
leniya.

The tracked chassis houses a launcher with 4 combat-ready missiles on each side. The antenna for the J-band radio command guidance system is mounted on a rising bracket-type mechanism; when deployed, missile launches are allowed. The rotating platform houses a pulse-Doppler radar for detecting air targets with a range of 11.5 km, a computing device, and identification equipment for the “friend or foe” system. The turntable rotates 360°. The Mk.I missile is identical to that used in the Rapier towed complex. It does not require maintenance or inspections during storage. The warranty period is 10 years.

The missile consists of 4 main sections - a warhead, a guidance system, an engine and a control system. There are safety and actuator mechanisms and a contact fuse. The last section - the control system - consists of an actuator driven by a gas jet, which allows you to control the rocket in action.



Launcher in combat position

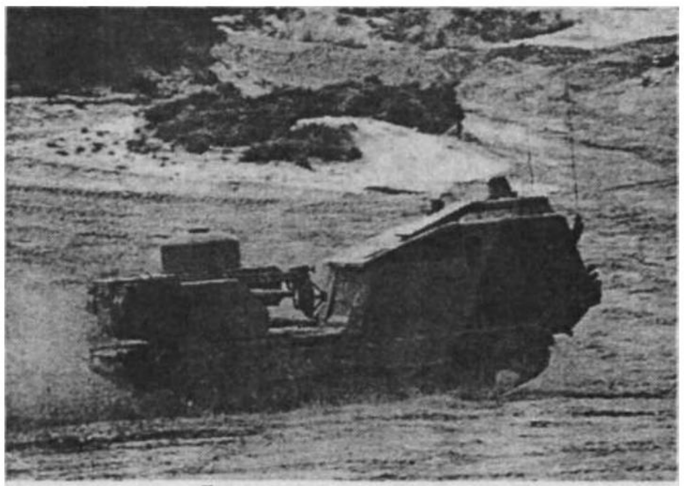
summer The last section has four tracers (signal lights) that facilitate TV acquisition and tracking.

The missile has high maneuverability and can maneuver with high overloads at maximum flight range in order to destroy maneuvering targets. The manual reloading time for eight missiles is more than *5* minutes. The average probability of hitting a target with one missile is 0.7.

When performing a march, the complex is ready to start shooting 15 seconds after stopping. The reaction time for the first rocket is 5 s, for the second - 2 s. Leaving the firing position is possible 20 seconds after completion of shooting.

The surveillance radar rotates in a circle. When found
The target is automatically identified as a nationality using the “friend or foe” identification system. If the target is foreign, the operator is notified by a sound signal in his headset. Simultaneously rotating platform with optical system automatically

turns towards the target along with the missiles.
If necessary, the operator can perform manual rotation for more accurate targeting. After capture
targets for tracking, the operator begins to track the target,
using the joystick. The operator can identify the target



Пусковая установка на марше

visually. Information from the optical tracking system and surveillance radar is sent to a computing device, where the possibility of a target entering the affected area is calculated. When a target enters the affected area, it lights up -
The signal light is in the operator's field of vision and he immediately presses the missile launch button. The computer determines the expected meeting point. The missile is automatically captured and aimed at the intended meeting point by the optical system. During the missile's flight to the meeting point, the operator must accompany the target. After the end of combat work, the operator can move on to searching for new targets or launch a second missile at the same target, as well as another one in his field of vision.

To ensure all-weather combat operations, the Rapier self-propelled air defense system can be equipped with another tracked chassis with a GEC-Marconi radar and a target tracking radar and a Defense Systems Blindfire radar. During combat operation, the Blindfire radar accompanies both the missile and
target with a very narrow beam.

In addition, each TRLV tracked chassis is complemented by an M548 tracked chassis - TRSV (Tracker Rapier Support Vehicle) with a crew of 2 people, having on board an ammunition supply of 20 missiles located in their transport containers -
nerah.

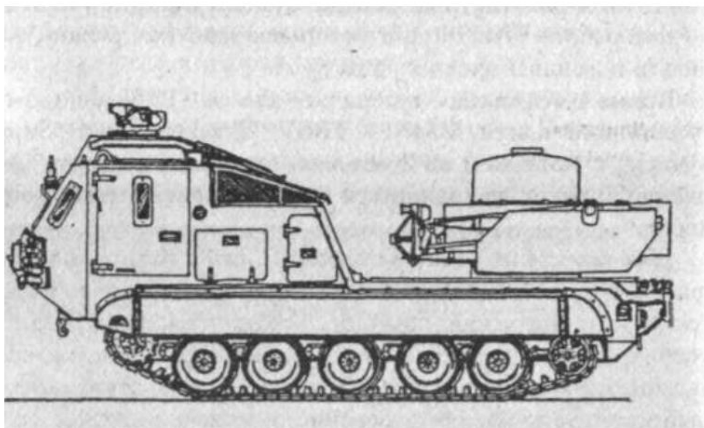
A special chassis of the FAST (Forward Area Support Team) type was also created for the Rapier complex to provide urgent technical assistance and maintain the serviceability of the main combat tracked chassis TRLV. The crew consists of two people, there is communication equipment, a crane, test equipment and spare equipment.

Combining a thermal imaging channel with an optical channel
The target tracking feature makes it possible to carry out combat work in a passive mode at night (without broadcasting radar equipment) until the missile is launched. The equipment of the thermal imaging channel TOTE is mounted together with the optical system. The essence of combat work remains the same. Therefore, a self-propelled complex without TOTE equipment has the index SP Mk.lA, and with TOTE equipment - the index SP Mk.lB.

Deliveries of equipment with the SP Mk.lB index to the British Armed Forces began in 1993. The Rapier self-propelled complex is all-terrain, amphibious, one chassis can be delivered anywhere in the world using a C-130 transport aircraft. The chassis has a low profile and, accordingly, low visibility, a small infrared signature and the ability to passively view space. The self-propelled system is compatible with all types of Rapier missiles, including the new Mk.2 missile.

Production of the complex has been completed. As of 1997, 72 complexes were in service with Great Britain. It is planned to remove it from service and replace it with the Shorts Starstreak complex.

The complex saw action between Britain and Argentina in the Falklands Conflict, the Iran-Iraq War and the Gulf War.



TACTICAL AND TECHNICAL CHARACTERISTICS OF THE MK.1 ROCKET

Damage range, km: maximum	7.0
minimum	0.25
Damage height, km:	
maximum	3.35
minimum	0.015
Rocket length, m	2.24
Rocket diameter, m	0.13
Wingspan, m Rocket	0.38
mass, kg Warhead	42.6
mass, kg Maximum missile	1.4
speed, M Reloading time, min Warhead	>2
type	5 semi-armor-piercing with contact fuse solid propellant,
Engine	single-stage, dual-mode Command missile guidance method

TACTICAL AND TECHNICAL CHARACTERISTICS OF THE CHASSIS

Crew, people	3
Total weight, kg	14,010
Ground pressure, kg/cm2	0.63
Length, m	6.4
Width, m	2.8
Height, m:	
with deployed optical system	2.78
during air transportation	2.50
Clearance, m	0.41
Maximum speed, km/h:	
on land	48
on water surface Fuel	5.6
capacity, l Turning	398
radius, m Travel range	4.3
without refueling, km	300

"Rapier-2000"

(GREAT BRITAIN)

In 1986, the English company British Aerospace signed a contract for the development, creation and serial production of the new short-range air defense system "Rapira-2000", designed to combat promising air targets, including cruise missiles, unmanned aircraft, fire support helicopters, as well as

targets flying at low altitudes in conditions of strong radio interference. The creation of the short-

range air defense system "Rapier-2000" (it received the code "Field Standard C" [Field Standard C]) began in 1983 as part of a program to modernize the Rapier complex, commissioned by the UK Ministry of Defense.

The main improvements of the "Rapira-2000" complex over the existing short-range "Rapira" complex were to be an increase in the rate of fire, an increase in the degree of automation of the combat work process, modernization, and in essence - the creation of a new missile, increased interference

protection of all elements of the complex from radio-electronic countermeasures and the effects of damaging factors of a nuclear explosion.

The signed contract with the UK Ministry of Defense provided for the rearmament of one Royal Artillery air defense regiment (3 batteries of 4 firing units each) and four artillery battalions of the Royal Air Force SHORAD air defense regiment, as well as a training center. In November 1993, British Aerospace announced that the Rapier-2000 complex had entered the

mass production stage and received a certificate from the British Ministry of Defense. Initially it was planned to produce 205 complexes; in reality, 57 were produced in 1997.

Launcher

In February 1995, the complex entered service with the air defense regiment stationed in Germany at that time. The official announcement in the NATO bloc about the adoption of the complex for service took place on April 1, 1996.

The Rapier-2000 complex consists of three main elements, each of them is placed on a unified single-axle trailer, towed by a 4-ton cross-country vehicle (4x4 wheel arrangement), in addition, the vehicles transport ammunition from 15 missiles and spare equipment.

The Rapier-2000 complex can destroy targets in a circular manner with the far border of the affected area at a range of 8000 m, at a height of 5000 m. The launcher has 8 combat-ready missiles and a thermal imaging station for tracking targets and missiles, ensuring the destruction of targets at any time

days, day and night.

During the day, an optical channel is used to capture and destroy targets. Thermal imaging station, mounted between two missile guides, it carries out a passive scanning mode, which can be used to acquire targets and track them both during the day and

at night.

The transmitter of guidance commands for an anti-aircraft guided missile is mounted on a rotating device, made in the form of a flat lattice, and sends coded control commands

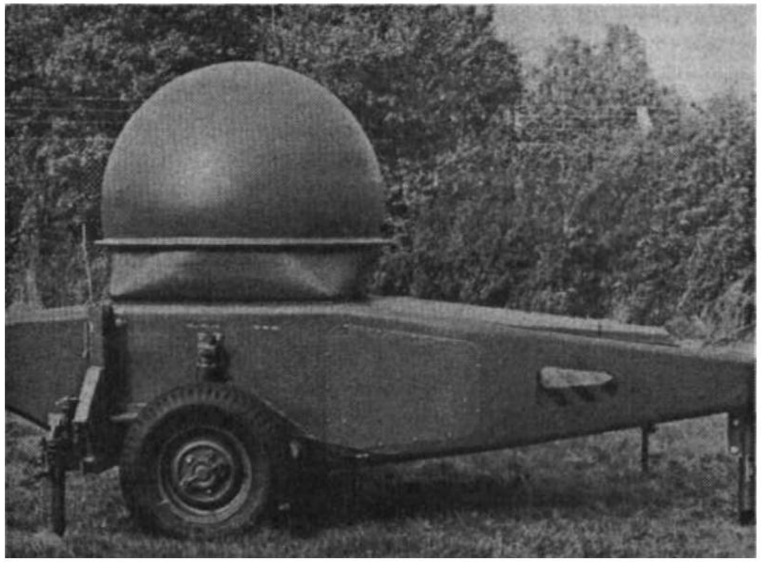
focusing on the rocket during its flight.

The second element of the complex is the Dag-Ger surveillance radar from Plesser. The radar is a coherent-pulse radar with Doppler signal processing. It has a multi-beam (in elevation) radiation pattern with a low level of side lobes and good resolution of targets from the group. The radiation pattern is formed by a flat array consisting of 1024 emitters. The transmitter is a compact high-power transmitter, made on a traveling wave lamp, which is cooled by a liquid cooling system. There is a broadband receiver and a high-speed processor. When an anti-radar missile attack is detected, the station automatically turns off. There is a request for a "friend or foe" identification system.

The Dagter radar can simultaneously track up to 75 targets along three coordinates. It detects hovering helicopters and small targets such as remotely piloted aircraft. Using modern methods of filtering reflected signals, the station is capable of detecting small targets against the background of the earth's surface. Good range resolution and frequency modulation signal tuning eliminates range ambiguity and mutual interference of targets.

The most important target tracks are displayed on the indicator tore of the TCU (Tactical Control Unit).

The characteristic features of the Dagger station are quite significant radiation power at relative but small mass-dimensional characteristics (weight 860 kg), wide dynamic range of the receiving device, high data processing speed and the use of ultra-large integrated circuits, including up to 70 thousand logical elements. In addition, the radar has high reliability, as evidenced by the reliability of its operation (mean time between failures 600 hours), as well as good



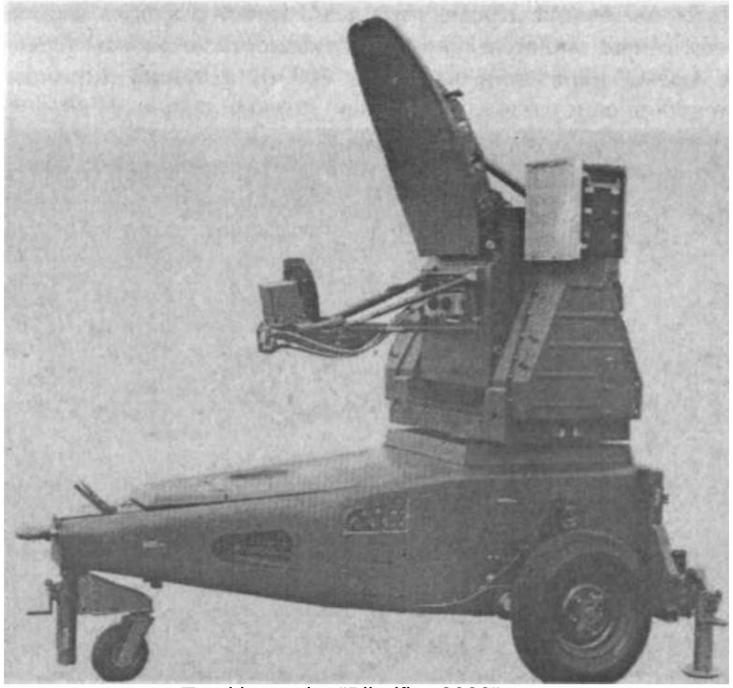
Surveillance radar "Dagger"

operational characteristics. Thanks to the built-in test, the operation of all equipment is automatically monitored, and the average recovery time is 30 minutes.

MAIN TACTICAL AND TECHNICAL CHARACTERISTICS of the radar

Target detection range, km 20 Operating frequency range, GHz 10—20 Width of directional pattern in azimuth, deg. 2

The third element, the new generation Blindfire-2000 radar, makes the Rapier-2000 complex operational in any weather and time of day. Being a modernized version of the DN-181 radar of the Rapira complex, it has higher operating secrecy and noise immunity due to the use of a signal with linear frequency modulation. In addition, at the new station, on the side of the main reflector



Tracking radar "Blindfire-2000"

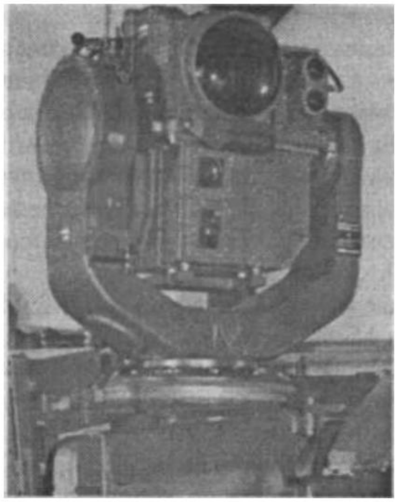
antenna (in place of the television camera), a continuous radiation transmitting and receiving device is installed, designed for quickly launching a missile (before it is captured by the Blindfire-2000 radar) onto the target line of sight. The missile guidance method implemented in this complex is similar to that used in the Rapier complex. It consists in the production by the Blindfire-2000 station of a signal proportional to

nal angular deviation of the missile from the target line of sight, which is then converted into control commands.

MAIN TACTICAL AND TECHNICAL CHARACTERISTICS of the Blindfire-2000 radar

Target detection range, km Operating	12
frequency, GHz Emitted	30—40
pulse power, kW Pulse repetition frequency, Hz	40
	4000

The use of two independent command transmitters in the complex (on the Blindfire-2000 station and the launcher), as well as two target tracking devices (optical-electronic and radar), allows firing at two targets simultaneously.



Optical-electronic target tracking device

Processing information coming from the Dagger radar or through a unified air defense information network, launching missiles and their guidance is carried out automatically using a special computing device. However, if necessary, the operator can independently identify the most dangerous target and fire at it manually. In addition, the presence of a special sighting device allows the air defense system calculation to determine the angular coordinates (azimuth and elevation angle) of a visually detected target (when there are no other sources of information) and transmit them to

one of the means of support.

The manual capture mode is also used when deploying the complex to a new position, when first deploying the launcher. As mentioned above, all three elements of the Rapier-2000 complex system use a common running base - single-axle

trailers that not only have good load capacity, but also low visibility due to smoothed shapes.

Each semi-trailer has its own diesel generator, air cooler and liquid cooling equipment.

Denia.

The semi-trailers are connected to each other by a fiber-optic cable, which increases the stability of operation when exposed to effect of an electromagnetic pulse.

All equipment is widely standardized, including power supplies, easy to test and replace.

The Mk.2 missile replaced the earlier version of the Mk.l missile in 1990. Externally, it is very similar to its predecessor, although all the main elements have either undergone deep modernization or have been replaced. The new rocket engine ensures 10-year storage of the rocket without any maintenance.

There are two modifications of the Mk.2 rocket: Mk.2A and Mk.2B. The Mk.2A modification retains a semi-armored warhead (as in the Mk.l) with a contact fuse. The Mk.2V modification can have two types of warhead: high-explosive fragmentation with a laser (remote) fuse, designed to destroy small targets, cruise and anti-radar missiles; and semi-armor-piercing warhead

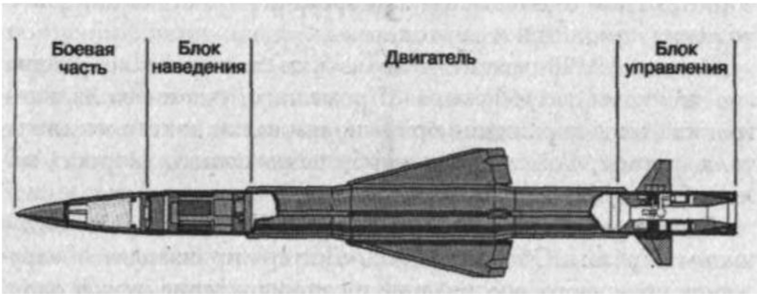
with contact delayed action fuse to destroy loss of airplanes and helicopters.

The Mk.2V missile can also be used in earlier versions of the Rapier complex. In addition, the range has been increased the boundary of the affected area when using a rocket engine a Royal Ordinance aircraft, providing a flight speed of more than M2.

The combat operation of the Rapier-2000 complex occurs as follows. The Dagger surveillance radar detects a target, identifies it and tracks another target. Information about the target's track is processed using an algorithm that assigns a target for destruction in accordance with pre-selected priorities (for example, firing at a target flying from a pre-selected priority direction). The operator selects the target tracking mode - radar or optical-electronic. With radar, the target is tracked automatically by the radar, the operator

presses the rocket launch button when hitting the meeting point missiles and targets into the affected area. Next, the launched missile is captured and aimed at the target. Missile guidance commands are transmitted to its board using a command transmitter. Already while the missile is in flight, the complex can engage in tracking of the next target and fire it, or launch a second missile.

This possibility was tested in real combat firing at the beginning of 1991. The first missile was aimed at the target using a radar, and the second was aimed at the second target using an optical-electronic station. The first target imitated an air target, and the second – a low-altitude target.



Missile Mk.2 of the Rapier-2000 complex

The complex is in service with the Royal Air Force and the British Army.

TACTICAL AND TECHNICAL CHARACTERISTICS
OF THE LAUNCHER OF THE RAPIRA-2000 COMPLEX

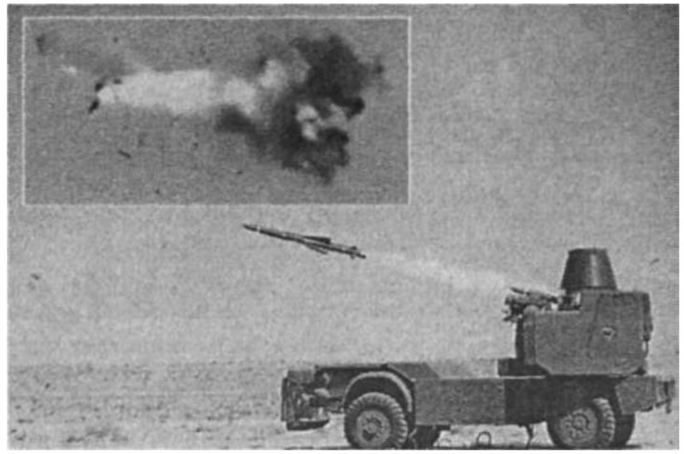
Weight, kg 2400 Length, m 4.1 Width, m 2.2 Height, m 2.6
Reloading time, min 2 Number of combat-ready missiles, pcs. 8
Target tracking mode: automatic or manual

TACTICAL AND TECHNICAL CHARACTERISTICS OF THE MK.2 ROCKET

Length, m	2.24
Diameter, m	0.13
Wingspan, m Launch	0.38
weight, kg Maximum	43
speed, M Permissible	2.5
overloads, g Far border of the	more than
affected area, km Maximum height of the	30
affected area, km	8.0 5.0

"Laserfire"

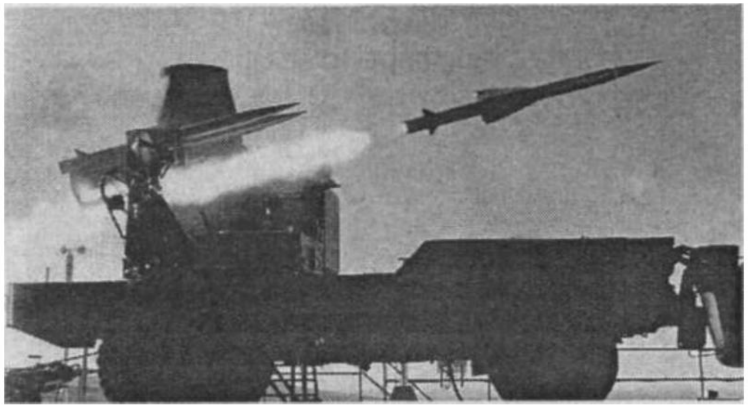
(GREAT BRITAIN)



In the early 90s, a message appeared in foreign periodicals about the successful completion of a series of live firings of the British Aerospace short-range air defense system "Laserfire", carried out in the interests of potential buyers in the Middle East, Asia and Africa.

During tests that took place in 1990 in the Middle East, and earlier in the UK, 100% combat capabilities of the complex were demonstrated. According to British Aerospace officials, it destroyed 90% of all targets. The Laserfire short-range air defense system uses the Rapier missile complex, as well as new equipment for target detection and missile guidance systems.

The complex provides automatic detection of targets using a surveillance radar in the millimeter wavelength range, and delivery of target designation to a laser target tracking radar. When a target enters the affected area, a signal is automatically sent to the operator, who immediately launches a missile (the principle is similar to that used in various modifications of the Rapier complex), which has a contact fuse and is automatically aimed at the target using a laser beam.



During live firing in the Middle East, the Laserfire short-range air defense system was tested in desert conditions, destroying targets such as the Banshee unmanned aerial vehicle at ranges from 3 to 5 km.

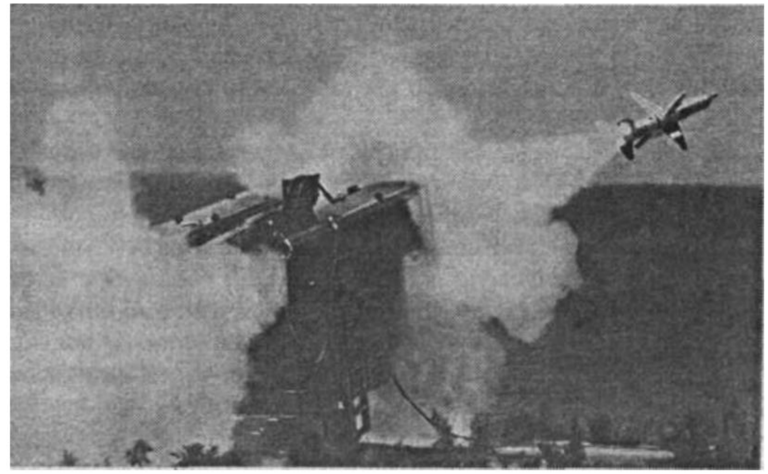
The warhead was detonated using a contact fuse; there were cases of a missile directly hitting the target and its destruction.

The launcher is mounted on a semi-trailer. The Banshee unmanned aerial vehicle is 0.1 the size of conventional aircraft.

Stationary version of the complex

"Spada"

(ITALY)



The Spada medium-range anti-aircraft missile system is designed for air defense of air bases, troop groups and other important military and administrative-political facilities. The system can be used against

airplanes, helicopters, as well as remotely piloted aircraft, including air-to-ground missiles.

Development of the complex began in the late 70s to the requirement of the Italian Air Force.

To reduce costs and reduce development time, it was decided to use components that had proven themselves in other systems. For example, the Aspide Mk.l missile is identical to that used in the naval air defense system. A modified Pluto radar station operating in the E/F wave range was used as a detection and target designation radar.

and as a tracking radar and target illumination

The Orion 30X J-wave band pulse-Doppler station, also used in the naval air defense system, was selected.

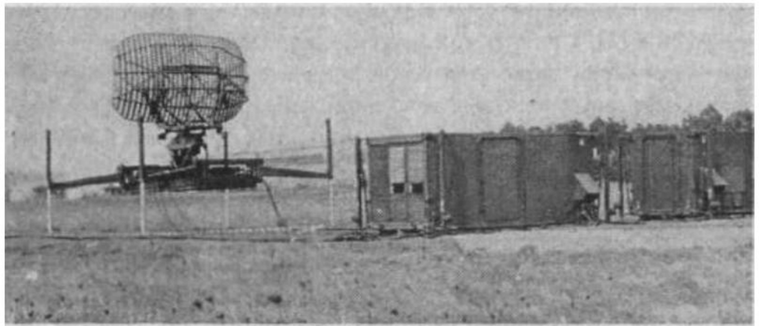
Testing of the prototype system was completed in 1977. The first battery entered combat duty in 1983, and by 1986 it was in service with the Italian Air Force

There were already 12 systems. Four more systems entered service by 1991. Thus, four battalions entered service with the Italian Air Force, each with four batteries of six launchers per battery. In 1986, the Taiwan Air Force placed an order for one complete Spada battery, which was delivered in 1988. In 1995, a system modernization program was initiated, aimed primarily at improving the control system and software. The result was a system capable of carrying out air defense of large areas with a high probability of hitting targets with one missile. It has a flexible configuration, good capabilities for searching, detecting targets, issuing target designation to fire units.

divisions and a high degree of immunity to interference.

A typical Spada battery includes a detection center and firing units. The detection center includes a detection and identification radar (consists of an antenna and a hardware container), an operational control center and power supplies.

One detection center is capable of controlling up to four firing nodes. Each firing unit includes two launchers (each with six missiles ready for launch) and a fire control center, consisting of a tracking radar and target illumination, a control center and power supplies. A television-optical sight is installed on the under-light radar.



РЛС обнаружения

The Aspide Mk.l missile is single-stage, solid propellant, with a semi-active guidance system. Guidance is carried out using the reflected energy of the illumination or the emitted energy of the jammer. The warhead is high-explosive fragmentation. The missile provides maximum target engagement range at a maximum range of 15,000 m and an altitude of 6,000 m. The probability of destruction is at least 0.8 even in conditions of interference and at low altitudes. The missile is stored in a sealed transport and launch container. The total time required to fire at the first target is 10-15 s and approximately 5 s for the next target. Since 1987, Aspide 2000 missiles can be used as part of the air defense system.

The firing unit can be deployed at a distance of up to 5 km from the detection center.

The maximum configuration battery can cover an area of up to 800 km ^{2} and have 72 missiles ready to launch, which can be fired one at a time or in a hall pom of two missiles.

The task of the detection center is to search, identify targets and issue target designation to fire units. Little is used as a detection radar.

Anteina radar target illumination

high-altitude station capable of operating in the presence of interference. Combat control in the battery is carried out by the operational control center, which includes three workstations

operators with standard indicators, processor data processing and multiple digital and analogue our communication lines.

The main task of operators is to check the correct operation of automatic systems and determine the need to intervene in the operation of the system, especially in conditions

interference

The detection radar is two-dimensional, coherent-pulse, operates in the E/F wave range, the maximum detection range is 50 km.

Fire units are designed to track and destroy detected targets. The Target Illumination Radar (TIR) tracks and illuminates the target to provide missile guidance. It is equipped with a moving target indicator (MTI). Additionally, TIR can search for a target (in circular or sector search mode). The television-optical sight is used as a radar backup for recognizing targets and monitoring firing results. The operation of firing units is controlled automatically

or manually.

Launchers (ML) provide storage, guidance, selection and launch of missiles. Digital and analog communication lines are used to communicate with the fire control center. The launcher can be rotated in azimuth by

Launcher in stowed position

360° at a speed of 50 degrees/s and has a constant launch angle of 30°. For loading and unloading, as well as for transportation, the launchers are set at a zero angle. The launcher is loaded using a special hydraulic crane installed on a FIAT truck (bkhb), in the back of which the missiles are transported in the TPK. The air defense system is semi-stationary, the detection radar

equipment of the operational control center and center

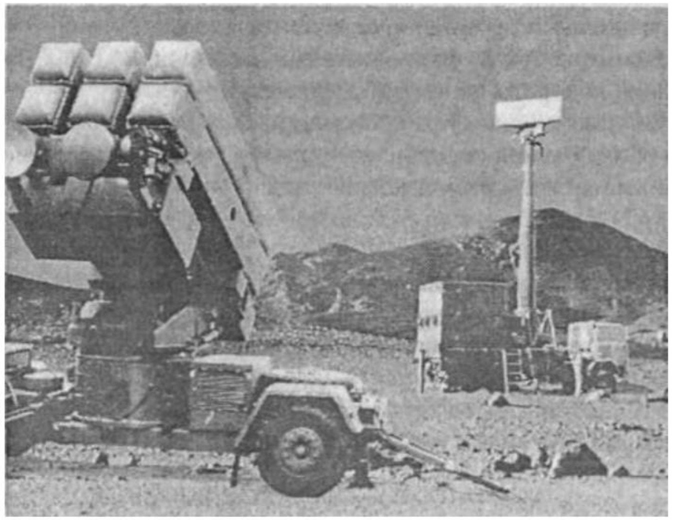
The fire control unit is housed in standard hardware containers, which are equipped with special jacks for installation on the ground. Launchers, platforms with detection radar and illumination radar antennas are also installed on the jacks. Electric power generators with a capacity of 75 kW are placed on single-axle trailers.

The air defense system is in service with the Italian Air Force, the Royal Taiwanese Air Force, and the Spanish Air Force with Aspide 2000 missiles.

TACTICAL AND TECHNICAL CHARACTERISTICS

	Aspide Mk. 1	Aspide 2000
Radar detection		
range, km	50	50
lesions maximum	15	20
Damage height, km:		
maximum		
minimum	6	8 0.01
Rocket length, m	0.01	
Diameter, m	3.7 0.20 0.20 0.68 0.68	
Wing span, m	2.0 >2.5 220 241 high-	
Rocket speed, M Rocket	explosive fragmentation	
launch weight, kg Warhead		

Aramis/Aspide
(ITALY)



The towed medium-range anti-aircraft missile system is designed for air defense of brigade combat formations. It includes a battery fire control post and a towed launcher. The battery fire control post (a command post with a crew of two people) is mounted on the

chassis of an all-terrain truck and combined with a target detection radar mounted on the same truck. The two-coordinate radar is capable of detecting (at a range of up to 50 km), identifying (determining nationality) and tracking up to 100 targets. The radar antenna is raised on a mast to a height of up to 10 m.

The fire control post module is located behind the antenna mast and monitors the air situation based on detection radar data, the state of the launchers and control commands from a higher command post. All information is displayed on the color display. The post is equipped with a GPS navigation system that provides accurate

location determination.

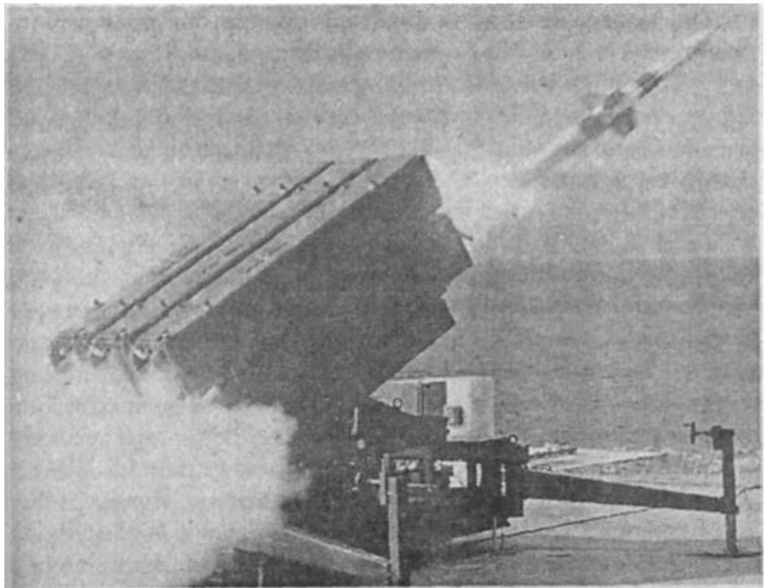
Tracks of tracked targets are prioritized based on assessed threats. The target selected for firing is assigned to one of four launchers

Aspide. If required, data on tracked targets can be automatically transmitted to other air defense systems via a radio link through a special terminal at a range of up to 10 km.

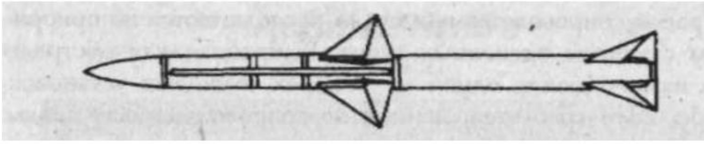
The unmanned (without crew) towed launcher Aspide LU has six missiles in transport and launch containers. It is controlled from a command post via a telephone line at a range of up to 1000 m or via a radio relay line at a range of up to 5000 m. The missiles are arranged in threes in two rows. The radio is also installed here.

target illumination motor.

After receiving target designation data, the launcher autonomously turns towards the target, captures, tracks the target and fires. Each launcher can fire at one target, i.e. the battery can fire at up to 6 targets simultaneously.



Пуск ракеты Aspide Mk.2



The system can use single-stage solid propellant missiles Aspide Mk.l or Aspide 2000. Guidance radar semi-active, using a homing head. Contact type fuse.

Selenia has developed a new modification of its Aspide short-range air defense system, equipping the Aspide Mk.2 missile with an active radar homing head (GOS). Serial production of the rocket and its replacement of

the old plan

was supposed to start in 1995.

TACTICAL AND TECHNICAL CHARACTERISTICS

Aspide Mk.1 Aspide 2000

Maximum damage range, km Height of damage, km: 15 15

maximum

minimum

Length, m

Diameter, m

Wingspan, m

Launch weight, kg

Warhead

Maximum speed, M

6 8 0.01 0.01 3.7

3.7 0.203 0.203 0.68

0.68 220 241 high-

explosive fragmentation

2.0 2.5

NASAMS

(NORWAY)

The medium-range mobile anti-aircraft missile system is designed to destroy air targets at low and medium altitudes in all weather conditions.

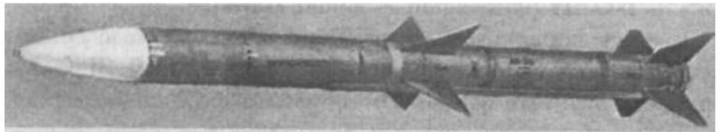
The development of the complex began in 1989 and was completed in 1993 with field tests. Since 1994, the air defense system has entered service with the Norwegian Air Force. NASAMS (Norwegian Advanced Surface-to-air Missile System) should replace the Advanced Hawk complex. It was developed by the Norwegian company Norsk Forces Technology AS together with the American company Hughes Aircraft. To reduce the costs of its creation, it was decided not to design new missiles, a radar station and a point

management, but to modernize those in service samples. For this purpose, the company selected the American AMRAAM (AIM-120A) air-to-air missile, the three-coordinate AN/TPQ-36A PAC and the fire control center of the Norwegian version of the Advanced Hawk complex - NOAH (Norwegian Adapted Hawk).

In terms of a number of indicators characterizing combat capabilities, the new complex is superior to similar air defense systems "Improved Hawk". It has a greater degree of equipment unification and the ability to interface with

other systems. The number of service personnel is only 25% of the crew of the Advanced Hawk air defense system. NASAMS is capable of simultaneously tracking and hitting a larger number of targets; the reaction time and transfer of the complex from the traveling position to the combat position have been reduced. NASAMS uses a modified American AMRAAM (Advanced Medium Range Air-to-Air Missile) missile as a missile defense system. The missile is made according to a normal aerodynamic design and consists of three compartments: the head, warhead and tail. The main part of the onboard equipment is concentrated in the head compartment. The missile defense system is controlled using a combined guidance system: command-inertial at the initial part of the flight path and active radar homing at the final part. If the target does not maneuver, then the missile makes an autonomous flight using an inertial measurement unit (made on miniature gyroscopes, has a mass of about 1.4 kg). At the same time, it moves along the trajectory stored in the memory of the on-board computer before launch. In the event of a target maneuver, correction commands are sent to the missile defense system from the ground in accordance with changes in the current coordinates of the target. Commands are received by the on-board receiver of the command communication line, the antenna of which is located on the nozzle block of the rocket. Target acquisition by the radar homing head of the missile defense system (its transmitter is made on a traveling wave lamp) occurs at a distance of up to 20 km from the meeting point, after which it is actively homing.

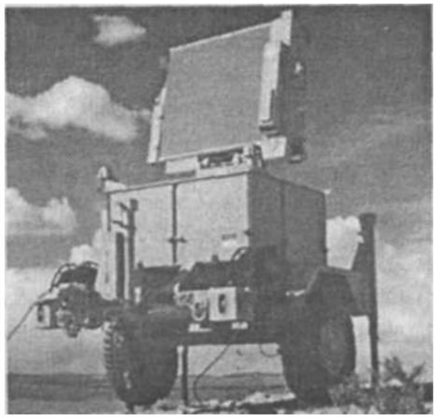
The missile is equipped with a high-explosive fragmentation warhead, which is detonated by an active radar or contact fuse. The seeker control, as well as the generation of commands for the autopilot and fuses, are carried out by a high-speed on-board microcomputer operating at a clock frequency of 30 MHz and having a memory capacity of 56,000 16-bit words.



Общий вид ЗУР AMRAAM

The missile defense system uses a dual-mode solid propellant engine, loaded with fuel based on polybutadiene with terminal hydroxyl groups and having reduced smoke generation. SAMs are stored, transported and launched from transport and launch containers. A package of six such TPKs is placed on a launcher mounted on a Scania all-terrain vehicle (6x4 wheel arrangement). Missiles are launched at a fixed elevation angle of 30°. In the stowed position, transport and launch containers with missiles are located horizontally. To increase the survivability of the complex, it is planned to disperse the launchers from the positions of the control point and the RAS over a distance of up to 25 km, while communication with the installations can be organized via cable, fiber-optic or digital communication line.

The AN/TPQ-64 multifunctional radar station, developed on the basis of the AN/TPQ-36A artillery position detection radar, provides detection, identification and simultaneous tracking of up to 60 air targets, as well as guidance on up to three selected of them SAM. RAS - pulse-Doppler, three-coordinate, has an integrated interrogator “friend or foe” type Mk.XII. RAS is reviewing the travel due to mechanical rotation of the antenna in azimuth and electronic rotation in elevation. The operation of the RAS is controlled using a computer at the fire control point.



Radar station AN/ TPO-64

The station's phased array forms a needle-type radiation pattern with a low level of side lobes. The radar is capable of compressing pulses, selecting moving targets, and changing the power and type of emitted signal. All station equipment is installed on a towed

flail

Information about the air situation from the radar (data update period is 2 s) is transmitted to the fire control point (FDC), which includes two high-performance computers, a multi-purpose console of a modular design with indication and control systems, data transmission equipment and communication equipment. The console has two overlapping automated workstations with identical controls. Each workstation is equipped with three displays, two of which display the entire air and combat situation, and the third shows the status and readiness of the complex's systems. Detailed information about the direction of movement, speed and altitude of any target can be obtained by the operator by entering an azimuth marker and pressing the readout button to display them on the indicator screen.

The firing unit of the complex is a platoon armed with three launchers with six missiles in transport and launch containers (TPC) on each, a multifunctional phased array radar and a fire control point. The main tactical unit of the NASAMS air defense system is the battery. It consists of three fire platoons (a total set of 54 missiles), united in an information network in such a way that each of the three radars is capable of replacing all the others. The battery command post (located at one of the fire control posts) can receive target designation from higher headquarters and provide data on the air situation to several (up to eight) short-range complexes. The cost of developing and deploying six NASAMS air defense missile batteries by 1999, according to Western experts, is $250 million. All batteries are deployed in the areas of Norway's six main air bases. In October 1996, a decision was made to increase the air defense of 6 batteries located in the strategically important northern part of Norway. For this purpose, the complex was modernized and received the name NASAMS P. He •

will have more elements than its predecessor and include 4 platoons instead of three, six radars instead of three and 12 launchers instead of nine. The battery will be more mobile, as it is installed on a self-propelled all-terrain chassis of the Bv 206 type. The launcher software will be changed to be compatible with communications systems used in the army.

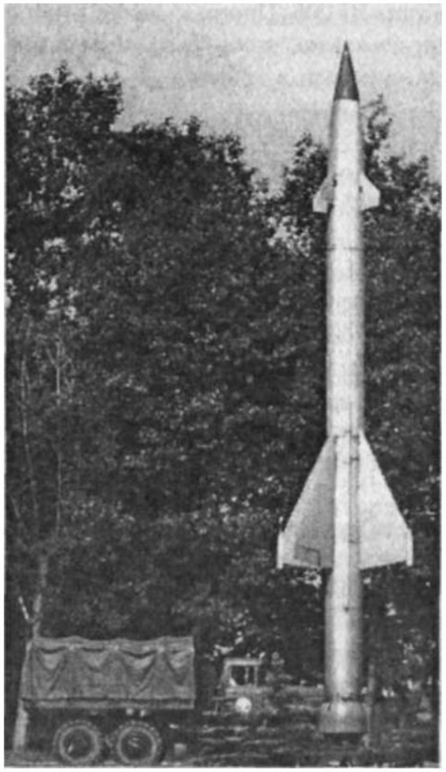
TACTICAL AND TECHNICAL CHARACTERISTICS OF THE RADAR

Detection range (target RCS 3 m^2), km	75
Operating frequency range, GHz	8—10
Viewing area,	
degrees: in	360
azimuth by	60
elevation Angle of review in azimuth,	180
degrees/s Coordinate determination accuracy:	
by range, m by	30
azimuth, deg. by	0.2
elevation angle, degrees.	0.17
Resolution: by range, m by azimuth,	
deg. by elevation	150
angle, degrees. Mean	
time between failures, h	2
	1.7 300

TACTICAL AND TECHNICAL CHARACTERISTICS OF THE ROCKET

Weight, kg:	
missile	157
warhead Damage	22
range, km: maximum	40
minimum	2.5
Damage height, km:	
maximum	16
minimum	0.03
Probability of hitting a target with one missile Reaction time,	0.85
s Transfer time, min:	10
from combat position to	
traveling position from traveling position to	
combat position	3
Maximum speed of the target hit, m/s Missile length,	15
m Body diameter,	1000
m Rudder span, m	3.65
Maximum missile	0.17
flight speed, m/s Available overloads, g	0.63
	1020 40

S-25
(Berkut"
(RUSSIA)



In the late 1940s and early 1950s, the Soviet Union began one of the most complex and expensive programs of the early Cold War, second only to its nuclear weapons program. In the face of a threat from the strategic bomber forces of the United States and Great Britain, J.V. Stalin ordered the creation of an air defense missile system controlled by a radar network to repel possible massive air attacks on Moscow. The Moscow system was followed in 1955 by a second program aimed at protecting Leningrad.

After the end of World War II, the Soviet Union began a program of using captured military personnel German technologies. Particular interest was shown in radar technology and anti-aircraft missiles. After a preliminary study of many types of German missiles, it was decided to focus on the Schmetterling and Wasserfall type missiles. On their basis, NII-88 specialists developed the R-101 and R-105 missiles, tests of which began in 1948. However, both types of missiles showed insufficient combat effectiveness, and the Soviet program was characterized by the same problems as Germany: through -

moderate concentration of attention on the design of the rocket and insufficient attention to more critical technological problems associated with the radar system and control (guidance) system. At the same time, other Soviet design bureaus, reinforced by German engineers, were researching key technologies. In particular, at NII-885 (Monino, Moscow Region), a semi-active radar seeker for anti-aircraft missiles was developed, which used the SCR-584 radar, obtained from

"lend-lease".

In August 1950, the task of developing a Moscow air defense system based on anti-aircraft missiles was assigned to the Moscow SB-1. The main designers of the system were S. Beria (son of L. Beria), a well-known radio specialist in the country, and P. Kuksenko, previously repressed. The system was named “Berkut” (based on the initial letters of the developers’ last names).

The Berkut strategic air defense system (SA-1 “Guild” according to the US/NATO classification) was intended to defend Moscow from air raids in which up to 1000 bombers could participate. In accordance with the tactical and technical requirements, it was necessary to develop a Control Center that would ensure the targeting of missiles at 20 bombers flying at speeds of up to 1200 km/h at ranges of up to 35 km and at altitudes from 3 to 25 km. Work on the Berkut system was distributed among several special design bureaus.

OKB-301, headed by S. Lavochkin, was entrusted

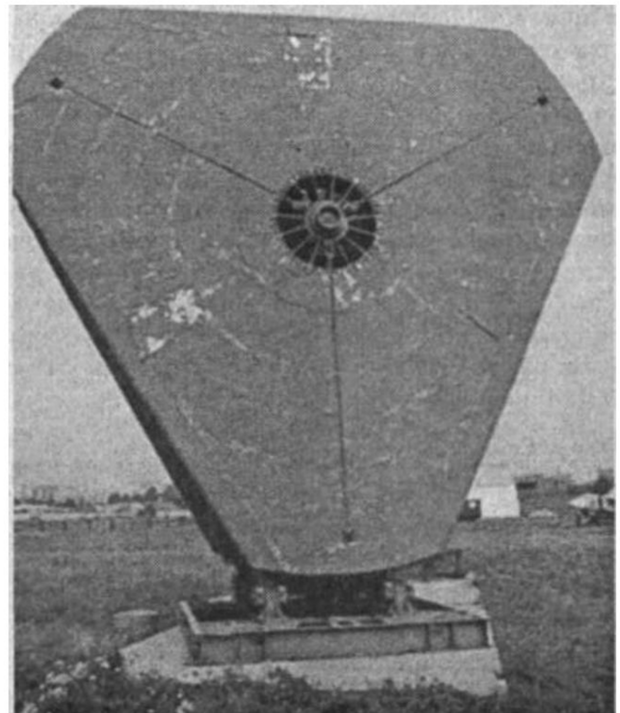
development of the associated missile V-300 (factory index "205"). It made extensive use of German technology, but was different from the previous R-101 system.

The B-300 rocket was single-stage, made according to the "canard" aerodynamic design: the air rudders were located in the bow of the body in two mutually perpendicular planes in front of two wings, installed in the same planes on the middle part of the body. The cylindrical body with a diameter of 650 mm was divided into 7 compartments. The tail was equipped with a four-chamber liquid propellant rocket engine ÿ9-29 with a displacement feed system, which developed a thrust of 9000 kg. Gas rudders were attached to a special truss in the rear part of the hull. The launch mass of the rocket is 3500 kg. The missile launch was carried out vertically from a special launch pad. The B-200 radar provided tracking of both the target and the missile, and issued control commands to the missile. The antenna systems of the B-200 radar scanned the space in the azimuthal and elevation planes. The radar measured three coordinates necessary to generate missile control commands. The missile was equipped with a proximity fuse, which was triggered at the final interception phase; the system did not have the ability to detonate on command. The E-600 high-explosive fragmentation warhead was supposed to hit an enemy aircraft from a distance of up to *75 m.*

Ракета В-300 на транспортно-заряжающей машине

Test launches of the B-300 missiles began in June 1951, i.e., less than a year after the start of the program. During the year, about 50 of these missiles were launched at the Kapustin Yar missile test site. Initial launches were associated mainly with aerodynamic and component tests, since the B-200 radar was not delivered to the Kapustin Yar test site until the end of 1952. Testing of the full system began in May 1953, when The Tu-4 bomber was shot down by a B-300 missile at an altitude of 7 km. The choice of target type was not accidental; the Tu-4 aircraft was a copy of the American B-29, which dropped atomic bombs on Hiroshima and Nagasaki. Refinement production missile models were tested in 1954, including the simultaneous interception of 20 targets.

After the death of I.V. Stalin, significant changes occurred in the leadership of the Ber-kut program. SB-1 was withdrawn



Антенная система РЛС Б-200

but from the subordination of the KGB, L. Beria was arrested, S. Beria was removed from work, and SB-1 was renamed KB-1 of the Ministry of Agricultural Engineering. The chief designer of NII-108, A. Raspletin, was transferred to KB-1 and headed the Berkut program, which was renamed the S-25 program.

Under the name S-25 "Berkut" the system was put into service and its serial production and deployment began. The most expensive element of the system was the launch sites and the necessary road network. It was decided to create two rings of missile regiments around Moscow: one ring at a distance of 85-90 km from the city center to deliver a decisive blow against bombers, and the other at a distance of 45-50 km to destroy bombers that broke through the first ring. In order to provide access to the launch sites, two ring roads were built. According to American intelligence estimates, the construction of these roads and launch positions in 1953-1955. The annual production of concrete has been used up.

Construction began in the summer of 1953 and ended in 1958. 22 anti-aircraft regiments were deployed on the inner ring, and 34 on the outer ring, i.e. 56 regiments in total. Each launch position consisted of four functional sections-zones: launch, radar, administrative, housing and technical and power transformer substation. The launch zone, with an area of more than 140 hectares, had a developed network of access roads and 60 launch facilities. At a distance of approximately 1.5 km, a command post was located in a bunker, occupying an area of approximately 20 hectares. On the territory of the point there was a B-200 radar, including an azimuth radar and an altimeter. The main BESM and 20 control posts were deployed in the bunker. Each regiment consisted of about 30 officers and 450 privates. Each facility contained three missiles with a nuclear warhead having a TNT equivalent of about 20 kt. Such

the missile could destroy all targets within a radius 1 km from the detonation point and was supposed to be used in the event of massive raids using nuclear carriers weapons.

The configuration of the position allowed the regiment to hit 20 targets simultaneously. Apparently, at the first stage, each regiment could fire at 20 targets with 20 B-300 missiles. After improving the system, shelling could be carried out by three missiles at one target, which significantly increased the likelihood

severity of the lesion.

In addition to the launch positions of the 56 regiments, six defense zones were built along the inner ring road. The positions of the S-25 system were supported by a large number of radars of the country's air defense system, which provided early warning and initial information on targets. NII-224 developed the A-100 surveillance radar specifically for these purposes, but other early warning radars could also be used. The deployment of the S-25 system coincided with a significant increase in the air defense radar network, particularly in the period 1950-1955. production ra-

radar equipment has increased fourfold.

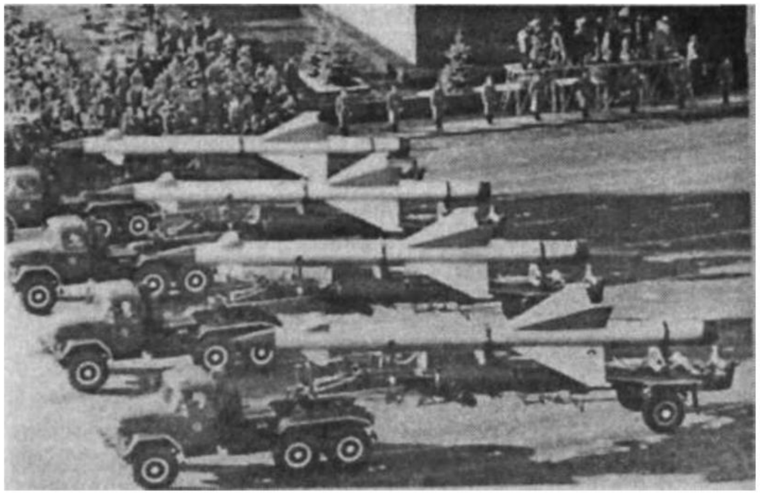
Serial production of the S-25 system began in 1954. By 1959, only approximately 32 thousand B-300 missiles were produced. This was 20 times greater than the scale of construction of ballistic missiles during the same period.

For the first time, the B-300 missile defense system was openly shown at a parade on November

7, 1960. The S-25 system was roughly comparable in scale and construction time to the American Nike-Ajax system. In the USA, 16 thousand missiles were produced and 40 divisions were deployed, in the USSR - 32 thousand and 56 regiments were deployed. The first division of the Nike-Ajax system was deployed near Washington in December 1953, somewhat earlier than in the Moscow Air Defense District. The large scale of production and deployment of the S-25 system in the USSR is partly explained by a simpler guidance system, which ensures the interception of one target by three missiles to achieve an acceptable level of destruction. The technical parameters of both systems were approximately the same, the effective range of destruction was 40-45 km. However, the B-300 missile was three times heavier than the American one, partly due to the larger warhead mass, but mainly due to the use of a less efficient single-stage design, unlike

from a two-stage Nike-Ajax rocket. In both cases, these systems were quickly replaced by more complex ones: Nike-Hercules in the USA and S-75 Dvina in the USSR. Like many of the first missile

weapon systems, the S-25 system, which N. S. Khrushchev called the “Moscow stockade”,
had obvious shortcomings even at the deployment stage. The system's assets were evenly distributed along the periphery of Moscow without strengthening the most likely directions of attack (Northern and Western). Insufficient density
The intensity of the fire might not have prevented a breakthrough by superior forces, or the defense might have been broken through even before the main bomber force arrived. Although the system was never used in combat, there is no reason to believe that the S-25 was well protected from electronic warfare. While US and British aviation gained significant combat experience in the use of electronic warfare during the Second World War and in Korea, in the USSR they were in their infancy. This made the S-25 system weakly protected from electronic jamming and other electronic warfare methods. The choice of a fixed configuration of combat positions limited the development of the system and its improvement. Huge command bunkers adapted to accommodate



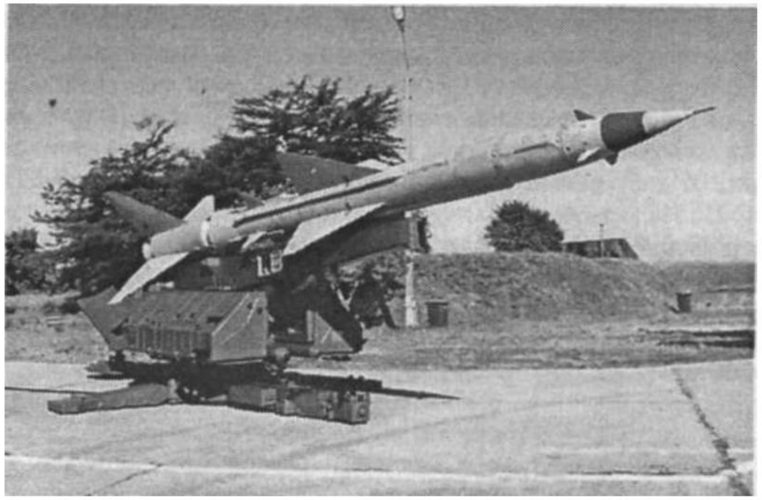
B-300 missile defense system at the parade on November 7, 1960

on them the RAS B-200 antenna system limited the azimuth capabilities of the station. The S-25 system could hit subsonic targets flying at speeds up to 1000 km/h, although at. bombers with supersonic speed appeared in weapons. And finally, in the mid-50s, the USA and USSR developed missiles launched outside the air defense zone: the American AGM-28F “Hound Dog” and the Soviet X-20 (AS-3 “Kangaroo”). They posed a threat because they had a significantly smaller reflective radar surface and

could be launched outside the affected area of the S-25 system. The disadvantages and high cost of the S-25 system led to the refusal to deploy it around Leningrad.

The S-25 system remained in service for almost 30 years, although its effectiveness continued to decline. In the 80s, it was replaced by the S-ZOP system (SA-10 “Grumble”).

S-75
“Dvina”, “Desna”, “Volkhov” (RUSSIA)



The S-75 anti-aircraft missile system (SA-2 “Guideline”) is designed to engage air targets at medium and high altitudes on a collision course and in pursuit. The transportable (towed) complex was developed to cover important administrative, political and industrial facilities, military units and formations. The S-75 is single-channel for a target and three-channel for a missile, i.e., it is simultaneously capable of accompanying one

target and aim up to three missiles at it.

Development of the complex began in 1953 at KB-1 (now Al-Maz). General designer A. Raspletin. The anti-aircraft guided missile was developed at the Fakel design bureau, general designer P. Grushin. The complex was created on the basis of technical solutions implemented during the development of the S-25 system. The launcher is single-beam with a variable missile launch angle and an electric drive for turning in angle and azimuth - designed at the Leningrad TsKB-34.

In 1955, an experimental test site version of the complex was created and the first missile launches were carried out. By mid-1956 an experimental model of a mobile station was created at

conducting missiles. The entire complex was housed in six cabins. The equipment cabins were located in automobile vans.

nah, transmitting and receiving equipment with antennas - on the ar-

Tillery cart KZU-16, launchers for transportation were installed on special wheeled chassis. Com-

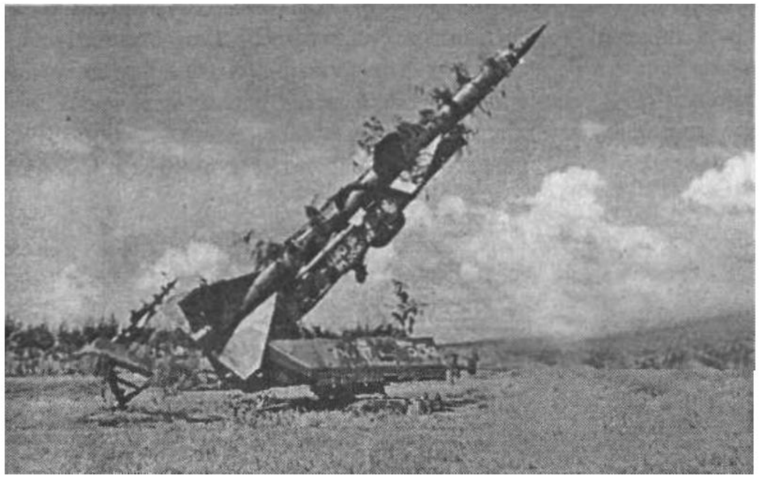
the complex had six launchers, which were placed in a circle around the missile guidance station (MNS).

In 1957, the complex called SA-75 “Dvina” entered service with the country’s air defense forces. The system's radar (missile guidance station) operated in the E-band. The complex fired at the target with V-750 (1D) and V-750V (13D) missiles.

Development of the S-75 Desna medium-range air defense system has begun in 1956, and a prototype test site was created in 1957. Taking into account the shortcomings of the SA-75 air defense system and other reasons, the new S-75 complex was designed with the placement of the equipment in towed van bodies mounted on the chassis of an automobile trailer The complex fired at targets with missiles of the new type V-750VN (13D) and had an expanded destruction zone compared to the previous one.

landlord

With the start of serial production and deliveries to the troops of the three-cabin version of the S-75 Desna complex, production of the SA-75 was curtailed.



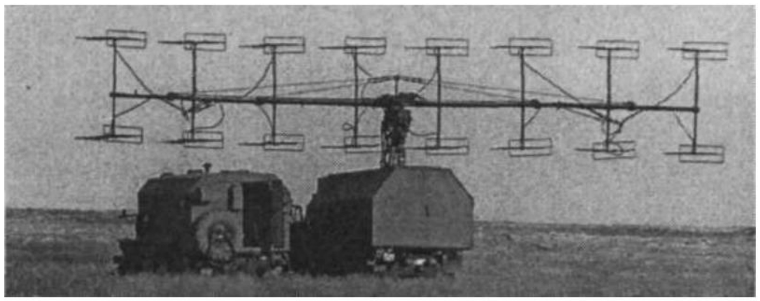
Camouflaged launcher of the S-75 air defense system of the Vietnamese air defense forces

The Vietnam War was the reason for a number of modifications to the Dvina complex. In total, 6 development projects were carried out with practical testing at the test site and subsequent implementation on equipment in Vietnam. A false launch mode was introduced, i.e., turning on the radio command transmitter for missile control without launching the missile. Having received such a signal on their reconnaissance receiver, tactical aviation pilots performed an anti-missile maneuver and thereby differed from strategic aircraft.

tions that could not perform such maneuvers.

The next modification was the S-75M Volkhov complex, which differed from the previous ones in the type of V-755 missiles used (20D and 20DP), as well as the presence of two parabolic antennas on the receiving and transmitting cabin. In the new rocket instead
Four antennas were used in the radio fuse, and the design of the rocket's propulsion engine was slightly changed. The missile guidance station operated in the G-wave band. Narrow beam parabolic antennas were installed on the wide-beam azimuth antenna, which increased the capabilities of the complex when working against small-sized targets and in interference conditions. The complex made it possible to fire at targets in conditions of active and passive interference. The S-75M entered service with the air defense forces in May 1961, and in 1962 it was adopted by the air defense forces of the ground forces. The complex was equipped with a communications cabin and interface with the automated control system, which allowed the missile guidance station to operate in automated external target designation mode. The use of automated control systems made it possible to increase the effectiveness of the combat use of air defense systems.

Later, variants of the S-75M2 complex were developed,

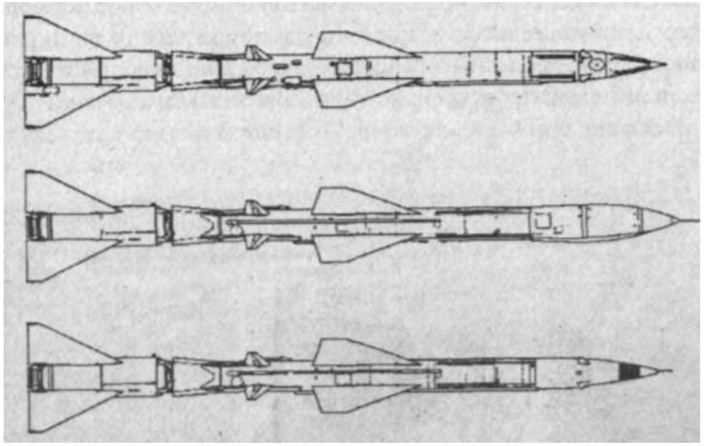


Target reconnaissance station P-1V

S-75MZ, which differed in the type of missiles used (20D, 5YA23) and the introduction of new operating modes of the SNR-75 for protection against interference. The complex was modified many times; at the last stage, a teleoptical sight was installed on the transmitting and receiving cabin. The television camera made it possible to fire at targets in conditions of electronic suppression of the SNR-75.

The rockets of all serial modifications are two-stage, made according to the normal aerodynamic design. The first stage (starting accelerator) is solid fuel and is a powder jet engine that operates for 4.5 s. The second stage has a liquid jet engine powered by a combination of kerosene and nitric acid. All-moving rudders for pitch control

motion, yaw and roll are located on the tail section of the sustainer stage, ailerons for roll control on the
during the flight with the launch accelerator - on the launch accelerator in the same plane. To reduce longitudinal static stability, trapezoidal destabilizers are placed in the nose of the rocket on rockets of early modifications and triangular - on rockets of later series. The warhead is a high-explosive fragmentation unit weighing 196 kg (for 20D missiles) and 190-197 kg (for 5YA23). The radius of destruction of the warhead can reach 244 m against U-2 type targets. For small targets such as a fighter, the damage radius is reduced



SAM projections

up to 65 m. The large radius of destruction allows you to compensate for errors in the guidance system. According to foreign press reports, the missile could have a nuclear warhead with a power of about 15 kilotons. On late-release S-75M complexes, to increase combat capabilities, the missile was aimed at

the target is also in the passive sector after the main engine is turned off. The warhead was detonated by a command from a radio fuse or by a command from a ground guidance station when approaching the target. Self-destruction of the missile is carried out

was due to a limitation of flight time or in case of a miss, regardless of the flight time. The missile is guided to the target by radio command. Missile control commands are generated by the missile guidance station equipment based on the relative position of the missile and the target* and are transmitted throughout the entire flight time of the missile. Reception of control commands on board the rocket begins from the moment the first stage separates, since the receiving antenna is covered by the launch accelerator. Transmission

Cha commands are carried out in the decimeter wavelength range.

The PV cabin has two antennas that scan in two orthoganal planes in angle (vertical) and azimuth (horizontal). The latest modifications of the Volkhov air defense system also have 2 parabolic antennas located on the azimuth antenna. The air defense system is in service with an anti-aircraft missile division, which includes a missile guidance station SNR-75 (3 cabins), an interface cabin with an automated control system,

launchers (6 pcs.), power supply equipment, and air reconnaissance equipment. Typically, the launchers are located in a circle at a distance of 60-100 m around the division command post (SNR-75). Elements of the complex can be located on the

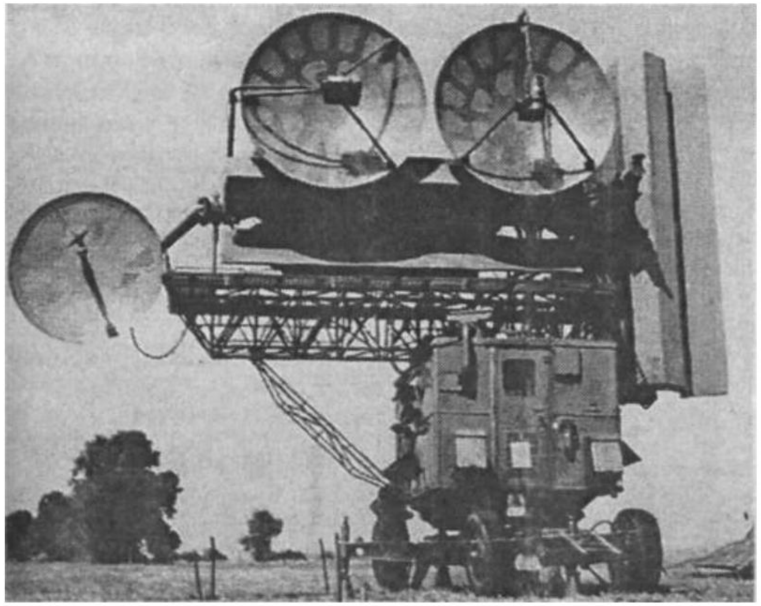

Транспортно-заряжающая машина комплекса С-75 с ракетами

covered areas, in trenches using bunds or in stationary concrete shelters. In this case, the PV (receiving and transmitting) cabin is in any case located in an open area and cannot be protected. The combat crew of the complex consists of 4 people - one officer and three escort operators based on angular coordinates and range. The air defense systems supplied to Egypt had their own characteristics. Instead of parabolic antennas, the horizontal antenna housed a cabin for two operators and equipment for optical tracking of targets. In cases of

radio-electronic suppression of SNR (radio interference), the operators located in this booth carried out visual

target tracking using angular coordinates.

The S-75 Dvina was first used in 1959 in China, where, at the request of the Chinese government, five fire and one technical complex were transferred. The Chinese shot down an American-made RB-57D reconnaissance aircraft of the Taiwanese armed forces. The shelling was carried out by three rockets and all of them were detonated. Airplane hit


Receiving and transmitting cabin of the SNR-75 missile guidance station

It was so strong that it fell apart while still in flight and its fragments scattered over a radius of 5-6 km. The pilot was killed by shrapnel. However, the fact that the plane was shot down by an anti-aircraft missile system was not announced in order to hide the presence in China of the latest (at that time) anti-aircraft missile systems. It was officially stated that the Chiang Kai-shek reconnaissance plane was shot down by the air force of the People's Liberation Army of China.

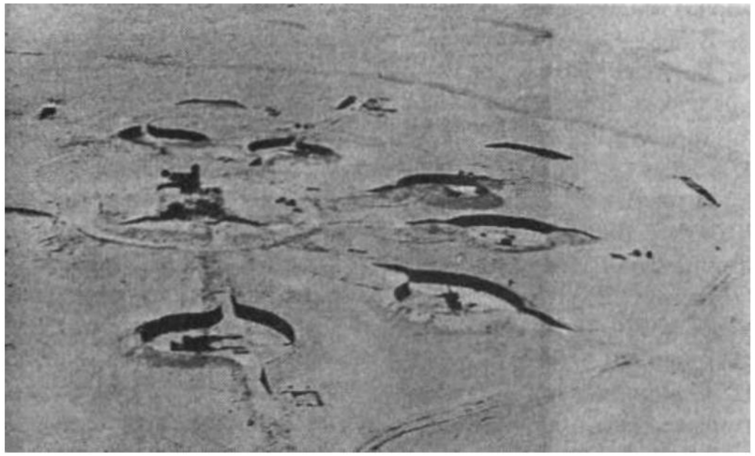
The S-75 air defense system was then used on May 1, 1960, when a high-altitude American U-2 Lockheed reconnaissance aircraft piloted by CIA pilot Powers was shot down near Sverdlovsk. The plane was shot down at 8:53 a.m. (Moscow time) by a single missile launched by the 2nd division of the 57th anti-aircraft missile brigade. The division was commanded by Major Mikhail Romanovich Voronov. The U-2 pilot did not die and managed to get out of the plane and, after a long jump, land 25 minutes later. He survived only because the missile was launched when the target had already flown past the launch zone and was exiting it. The rocket had to catch up with the target and it

Radar range finder RD-75

the combat charge exploded at the tail of the aircraft (15 m to the right and below). Already at the falling wreckage of the plane after the second division, another division was firing - Captain Shelud-ko. One of the missiles found its target. It turned out to be a wing. Having come off the plane, it fell on its own. Two other missiles flew between the wreckage of the U-2 and therefore did not explode, but self-destructed at high altitude. Unfortunately, on the same day, another plane was shot down - a MiG-19, piloted by senior lieutenant Sergei Ivanovich Safronov. The pilot managed to eject, but he was mortally wounded and landed dead. The cause of this tragedy was a series of overlapping errors: the calculation of the fighter control point, the actions of the calculation of the air defense command post, a technical malfunction of the interrogator of the division that carried out the shelling of the target.

The result of this use of the S-75 was that the United States stopped its reconnaissance flights over the territory of the USSR and thereby lost an important source of strategic intelligence information.

The next time the S-75 was used was in September 1962, when Chinese PLA anti-aircraft missile units shot down a Lockheed U-2. The Chinese armed forces used the S-75 and HOjl complexes of their own production, which are a copy of the Soviet system. These systems were used in the 60s



SAM position during the Arab-Israeli Six Day War of 1967

dy to combat U-2 Lockheed reconnaissance aircraft and unmanned reconnaissance aircraft of the Taiwanese armed forces and achieved victory approximately 8 times. On October 27, 1962, a US Air Force U-2 Lockheed was shot down over Cuba. In mid-1965, the C-75 complex was transferred to the North Vietnamese air defense forces, and in July of that year the first US Air Force F-4 C Phantom was shot down. Only from the beginning of use of the complex in Vietnam, USA

were able to obtain the first raw data about the missile guidance system, the missile guidance commands generated, the characteristics of the radio fuse and the missile warhead. These data made it possible to begin the development of electronic suppression systems for the S-75 air defense system. Especially for reconnaissance purposes, on February 13, 1966, an unmanned reconnaissance aircraft "Ryan 147E" was launched over the territory of North Vietnam, which transmitted intelligence data to the control post throughout its entire flight until it was shot down.

On July 22, 1966, another unmanned reconnaissance aircraft, the Ryan 147F, was launched, which was equipped with specially protected equipment for reconnaissance of the complex's characteristics. 11 missiles were expended before it was shot down. Throughout his reconnaissance

During the flight, the aircraft transmitted intelligence data to the point management.

In general, the use of the S-75 anti-aircraft missile system in Vietnam can be considered quite effective. For example, from December 18 to December 30, 1972, the American command carried out a carefully planned Operation Linebecker-2, in which all strategic aviation that took part in the hostilities was used (more than 700 aircraft, of which 83 B-52 and 36 F-111). Part of the forces of the 7th Fleet was also involved.

During the operation, more than 2,814 sorties were flown (1,810 at night) with an average daily intensity of 234 (151 at night). 12.5-14 thousand tons of bombs were dropped, 6000 shells were fired. The role of the main striking force was played by strategic aviation, which carried out 17 massive strikes - 594 sorties. It was used for the first time on such a scale

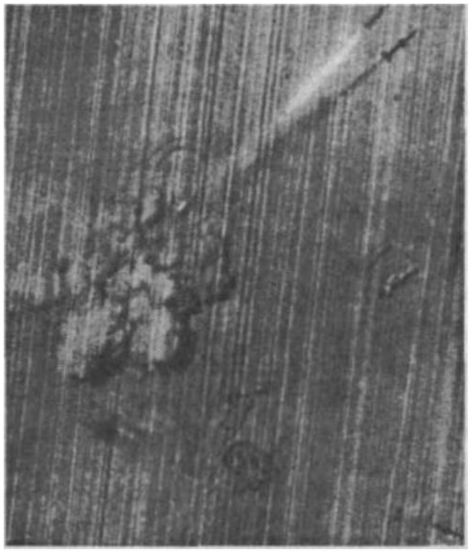
owl composition. Tactical aviation solved the tasks of supporting combat operations (approximately 60%), carried out strikes (approximately 36%), and conducted reconnaissance (approximately 4%). Vietnamese air defense forces destroyed 81 aircraft (31 B-52 and 3 F-111) of the US Air Force in 12 days. Air defense missile systems destroyed 54 (67%) aircraft, of which 31 were B-52s (91%). Anti-aircraft artillery shot down 20 (24%) aircraft, of which 3 were F-111s, 1 were B-52s. Fighter aircraft shot down 7 aircraft (9%), including 2 B-52s.

In total, 1155 firings were carried out in 1972; with a total consumption of 2059 missiles, 421 targets were shot down. Of these, 51 are B-52, 223 are F-4, 9 are F-105, *59* are A-6, 57 are A-7, 1 are Fill .

From 1965 to 1972, *95* air defense systems and 7568 missiles were delivered to Vietnam. By the end of the war (January 1973), 6,806 missiles had been expended. There were 39 combat-ready systems left; the rest were lost in battle or turned out to be faulty.

During the Vietnam War, more than 1000 aircraft (according to other sources - about 4000).

In 1965, the S-75 was used during the Indo-Pakistani War. The first of 25 complexes were deployed around Delhi and some key airfields. The only one



Launch the missile defense system. The photo was taken by an Israeli reconnaissance plane.

A confirmed case of combat use in this war was the defeat of an Indian Air Force AN-12 transport aircraft, which was mistaken for a Pakistani C-130 Hercules. In subsequent years, one Pakistani Air Force RB-57F reconnaissance aircraft was shot down.

In December 1965, an American Air Force RB-57F reconnaissance aircraft was shot down over the Black Sea near Russian coastal territory.

By July 1967 - the beginning of the war with Israel - Egypt had 18 S-75 air defense systems. In total, 35 firing systems and 6 technical ones (for preparing and servicing missiles) were delivered to Egypt. In total, Egyptian air defense systems launched 22 missiles and shot down 2 Mirag IIICJ on June 7 and 8. However, at the same time, one air defense system (including the SNR) was captured by the Israelis and another 8 were destroyed by the Israeli Air Force. On March 9, 1969, an Israeli Piper Cub surveillance aircraft was shot down. In the period before 1973, about 10 Israeli aircraft were shot down.

The S-75 was used during the 1971 Indo-Pakistan War (1 target shot down); during the 1973 war, when Syrian and Egyptian air defense forces shot down 14 targets; Syria in 1982 during the defense of the Bekaa Valley; Libya in 1986, during the incident with the United States; Angola against the South African Air Force.

The S-75 was repeatedly used by the DPRK and Cuba against high-speed SR-71 reconnaissance aircraft (no cases of defeat were recorded). The S-75 was used in November 1994 against NATO aircraft carrying out raids on western Bosnia. The Serbs used the S-75 against ground targets of Bosnian Muslims and Croats. About 18 missiles were fired in November-December 1994 at ground targets. In this case, the missiles were detonated upon contact with the ground or the detonation was carried out at low altitude. This was the reason why NATO forces suppressed the Bosnian Serb air defense systems.*

In China, the S-75 was produced under license under the name HQ-1 (complete analogue) and HQ-2 (improved version).

Iraq has modified the missile of its air defense systems with a thermal homing head, which is capable of guiding the missile at the final stage of flight. According to Iraqi military experts, *According to foreign press reports.

This will increase the probability of hitting maneuvering targets even in conditions of radio interference. If at the final stage of the flight the target is not captured by the thermal homing head occurred, then the missile switches again to the radio command - new guidance system.

Under the name "Volga" (export name), the complex was supplied to many countries around the world. Deliveries were made to Afghanistan, Angola (7 complexes), Algeria (5), Albania, Bulgaria (22), Hungary (16), Vietnam (95), Egypt (60), Yemen (20), India (16), Iraq, Iran, North Korea (45, including HQ;2), China, Cuba (24), Libya (18), Mozambique, Mongolia, Peru (3), Poland (40), Pakistan (2 HQ-2), Romania (20), Syria (23), Sudan (5), Czech Republic, Ethiopia (4), Yugoslavia (4).

TACTICAL AND TECHNICAL CHARACTERISTICS

	SA-75 “Desna”	S-75M “Volkhov”	S-75M2 “Volkhov”	S-75MZ “Dvina”
Target engagement range, km:				
maximum	29	34	43/56	43/56
minimum	7	7	7	7/6
Damage height, km:				
maximum	27	27	30	30
minimum speed	3	3(0.5)	3(0.1)	0.1
of the target being fired				
maximum forward speed, km/h 1100 Number of channels:		1500	3700	3700
targeted	1 11 1			
missile	3	3	3	3
Ammunition of				
an anti-aircraft missile division (SAM) 12 Number		12	12	12
of SAMs located at the launcher 6 Rocket length,		6	6	
m 1.06 Rocket diameter, m 0.5 Weight, kg: missile		6 1.08 1.07/1.09 1.07/1.09 0.5		
warhead		0.5 0.5		
	2287	2287	2390	2406
	196	196	196	197
Maximum rocket speed, M Starting engine			3.5	3.5
operating time, s				
	4.5	4.5	4.5	4.5

S-125 "Neva"

(RUSSIA)

The S-125 anti-aircraft missile system (Sa-3 “Goa” - according to the US/NATO classification) is designed to destroy air targets at low and medium altitudes. The complex is all-weather capable, capable of hitting targets on a collision course and in pursuit, and in exceptional cases, firing at radar-observed ground and surface targets.

Development of the complex began in 1956 at KB-1 (now Almaz). General designer A. Raspletin. The anti-aircraft guided missile was developed by the Fakel design bureau, general designer P. Grushin.

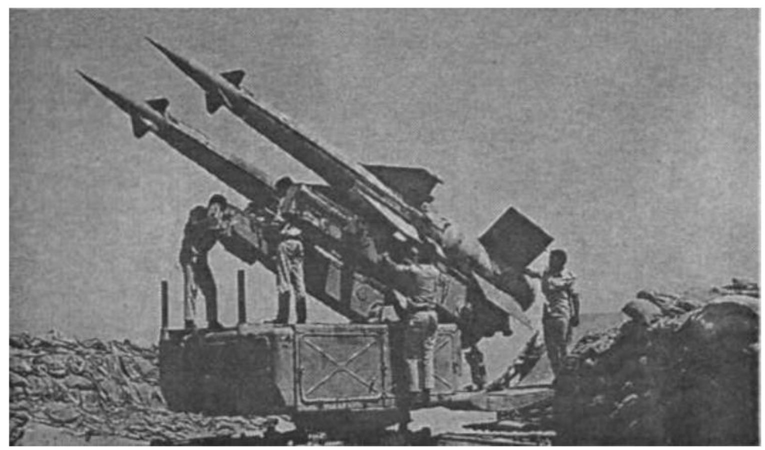
Testing of the complex began in 1961, at which time it was adopted by the air defense forces of the Soviet Army. At the same time, naval versions of the Ml “Volna” (SA-N-1A) and Ml “Volna M” (SA-N-3) complexes were developed for the Navy.

The 5V24 two-stage solid-fuel rocket is made according to a normal aerodynamic design. Its flight is controlled using commands generated by the missile guidance station and transmitted via radio link

control on board. The rocket has a solid-fuel launch engine, the operating time of which before being dropped is 2.6 s. The main engine is also solid fuel, it starts after the starting engine has finished working and runs for 18.7 seconds. After the launch accelerator is reset, the rocket begins to accept
mother of the control command for aiming at the meeting point with the target. The first stage (starting engine) is a PRD-36 powder jet engine (14 powder bombs with a total mass of 280 kg). The second stage engine is a powder bomb weighing 125 kg. The 4G90 warhead is high-explosive fragmentation, with ready-made submunitions weighing 60 kg (32 kg for explosives and 22 kg for submunitions). The rocket uses a Doppler radio fuse.

The radius of dispersion of fragments on targets of the F-4 type is 12.5 m. The missile has a radio fuse, removal of the first stage protection of which is carried out after the missile moves 300 m from the launcher. If the rocket is not
hits the target, it self-destructs.

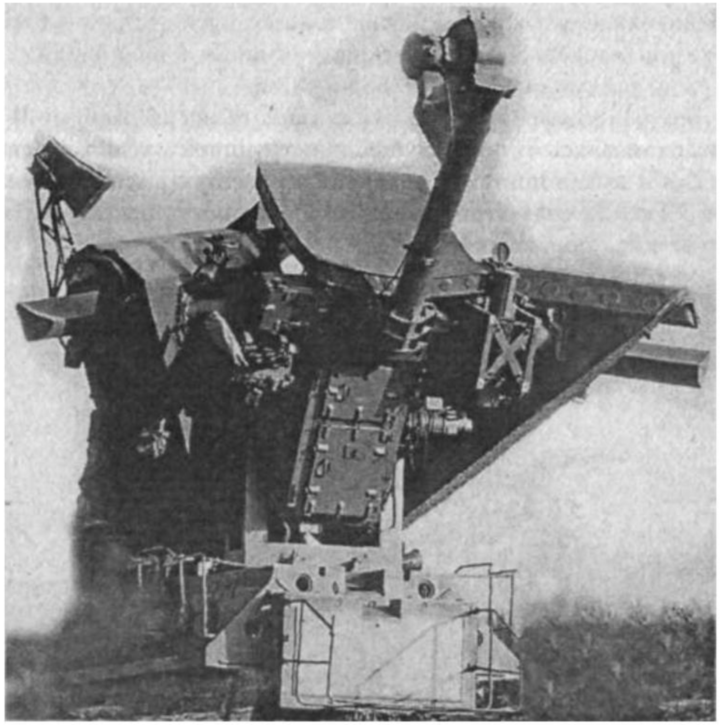
In 1964, a new 5B27 missile was put into service. It differed from the previous design of the main engine and had a new, more powerful 5B18 warhead weighing 72 kg. Due to this, the speed of the rocket increased and the
measures of the affected area.



Launcher 5P71 of the Egyptian air defense forces

To detect and track air targets, as well as to transmit control commands to the missile defense system, the SNR-125 missile guidance station is used, which operates in the I-wave band (8.9-9.46 GHz). It has specially configured antennas positioned to reduce the influence of ground reflections. The maximum target detection range is 110 km. The antenna radiation pattern width is 12°x1.5°. Antennas have a device

mechanical scanning of the beam, which allows simultaneous
It is possible to directly view a specific area of space. The SNR allows one or two missiles to be aimed at a target at the same time. To ensure the ability to work in conditions of interference, the station is equipped with a television optical camera that allows you to detect targets at ranges of up to 25 km, as well as monitor the results of firing.



Antenna post of the SNR-125 missile guidance station

The complex uses 5P71 or 5P73 launchers. One 5P71 launcher carries 2 missiles, and one 5P73 launcher carries 4 missiles. Charging time - 1 min. To transport and load missiles, a transport-loading vehicle based on the ZIL-131 or ZIL-157 (early versions) cross-country truck is used. The characteristics of the missile and warhead allow it to fire at both ground and surface radar-observable targets.

For early detection of targets, the division will include
A two-dimensional all-round radar station P-15 of the C-band (810-950 MHz) is in use. It has two parabolic antennas located one above the other and a radiation pattern width in the vertical plane of 5°, and in the horizontal plane - 2o. Many divisions are equipped with the P-15M radar, which differs in that the antenna can be installed on a tower with a height of 20 to 30 m. This increases the detection range of low-altitude targets.

To determine the height of tracked targets, the PRV-11 radar altimeter is used, operating in

ТЗМ на базе ЗиЛ-157

E-band (2.5-2.7 GHz). The maximum detection range is 180 km, the maximum detection altitude is 32 km.

The first combat use of the complex was registered in 1970. In Egypt, 18 divisions were deployed to cover the Suez Canal zone and other important administrative centers. Before the UN truce concluded in the same year, 5 F-4A Phantom aircraft were shot down with the help of the C-125.

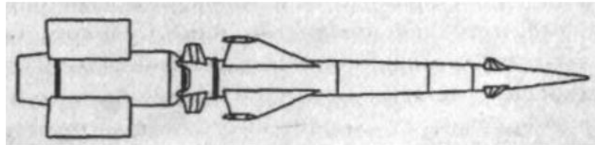
The main combat test of the complex took place in 1973, when Syria and Egypt used a large number of complexes against Israeli aircraft. By the beginning of the war, the Egyptians had 146 anti-aircraft missile divisions, about a third of which were S-125s. During this war, Arab air defense used up 2,100 S-75, S-125, and Kvad-rat missiles. They shot down 46 Israeli aircraft, 6 of them with the C-125 complex. During the war, some complexes were captured intact by the Israelis and handed over to American experts for detailed study. Since 1973, the C-125 has been used by the Armed Forces of Iraq (during the Gulf War of 1980-1988), Syria (for air defense of the Bekaa Valley), Libya (to repel raids by the US

Navy and Air Force in 1986 g.), Angola (to combat South African aviation). The complex was also used by the Iraqi Armed Forces during the Gulf War of 1990-1991.

8 C-125 divisions were used to defend Belgrade when repelling NATO air raids against Yugoslavia. According to some sources, it was with the help of a C-125 equipped with a Philips thermal imager that the F-117 stealth plane was shot down.

The S-125 air defense system was exported to many countries around the world: Afghanistan, Angola (3-air defense system), Algeria (5), Bulgaria, Hungary (6), Vietnam (40), Egypt *(55),* Yemen (3), India (12), Iraq, Korea (8), Cuba (12), Libya, Mali (3), Mozambique (3), Peru (2), Poland, Syria (40), Tanzania (5), Czech Republic, Finland (3), Ethiopia (8), Yugoslavia (8). The complex was exported under the name “Pechora”.

In Russia it has already been withdrawn from service, but in many countries it continues to be in service.



TACTICAL AND TECHNICAL CHARACTERISTICS OF S-125M1

Maximum detection range, km Target engagement range, km:	80
maximum	25
minimum	2.5
Damage height, km:	
maximum	18
minimum	0.02
Probability of hitting the target	0.4—0.7
Maximum speed of the target being fired , m/s: towards	
the catch	700
up	300
Alarm time No. 1, min: when powered from an industrial network when powered from a	4
diesel power plant	5—6
Number of target channels	
Number of missile channels	1
Ammunition (SAM)	2
Missile length, m	16
Missile diameter, m	5.94
Length of the second stage (without accelerator), m Weight, kg:	0.37 4.13
missile	953
warhead	70
Number of warhead fragments	1500
Fragment mass, g	4.8
Maximum flight speed, m/s Starting engine	730
operating time, s Main engine operating time,	2.6
s	18.7

"Pechora-2"

(RUSSIA, BELARUS)

The export version of the S-125 ("Pechora") air defense system, which appeared in service with the Soviet Army back in the 60s, has proven itself to be a very effective means of destroying air targets, in particular low-flying aircraft. In total, experts believe, about 1,200 S-125 air defense systems of various modifications were produced. Several hundred S-125 (Pechora) systems of various modifications were delivered abroad (according to some sources - up to 600) and several tens of

thousands of anti-aircraft guided missiles, most of which were widely used in combat operations in Vietnam, the Middle East and other places where they have gained great authority. To date, a significant number of S-125 air defense systems of various modifications are in service in 29 countries and neighboring countries.

By the beginning of the 90s, the urgent problem was carrying out a deep modernization of the Pechora air defense system, especially in terms of improving guidance systems, missile characteristics and increasing system mobility.

The air operation in Yugoslavia fully confirmed the relevance of this task. As follows from publications in the foreign press, the main efforts of the NATO aviation group, numbering 500 aircraft, were aimed at destroying primarily the S-125 air defense systems, which consisted of

air defense weapons of the FRY. According to the leadership of the alliance, of all the air defense systems of the FRY, it was the 14 anti-aircraft missile divisions of this system that posed the greatest threat to NATO aviation. As a result of attacks by cruise and anti-radar missiles, they suffered serious damage. But still, of the eight S-125 divisions located around Belgrade and subjected to the most intense attacks, two remained combat-ready until the end of the conflict. The fact that, despite the overwhelming superiority of the

stifling enemy, the tactics of the Yugoslav anti-aircraft gunners, together with the capabilities of the complex incorporated by the developers into the old Soviet weapons systems, were quite effective, according to official data from the Yugoslav side on NATO aviation losses. According to them, a total of 31 aircraft, 11 unmanned aerial vehicles, 6 helicopters and 40 cruise missiles were shot down over the territory of the FRY. If the majority of cruise missiles with subsonic flight speeds were shot down by anti-aircraft artillery barrage fire, then the F-117 "stealth aircraft" is considered destroyed by two 5B27 missiles

from the S-125 air defense system. It was possible to shoot down the F-117 largely thanks to the Philips thermal imager with which the shooting complex was equipped.

Military experts believe that one of the main shortcomings of the Yugoslav air defense systems was the absence of thermal imaging optical-location stations on most air defense systems, which in some cases reduced their combat effectiveness when operating at night. Along with this, the higher survivability of mobile computers was once again confirmed

Lex compared to stationary ones.

These conclusions from modern combat experience are largely taken into account when upgrading the S-125 air defense system. Presumably It is planned not only to qualitatively improve its main characteristics, but also to give the modified complex, designated "Pechora-2", a number of combat properties that are absent in the old system. The most important of them is the comprehensive mobility of the entire air defense system, which, in addition to the creation of mobile launchers, is ensured by

placement of reconnaissance and target designation stations, control cabins and

command posts.

During the modernization process, it is proposed to integrate into each source system blocks of modern electronic equipment currently used in the S-300PMU1 mobile air defense system. As a result, the complex has the ability to automatically receive and process information both from the command post and from reconnaissance and target designation stations. There will be the ability to detect and track targets via a television-optical channel at any time of the day, including in the infrared range. New electronic equipment of the complex and improved

existing anti-aircraft guided missiles are significantly
expand the far border of the target engagement zone from 17 to 27 km. During the modernization process, each missile is equipped with a new launch accelerator, an improved warhead and a radio fuse with improved noise immunity. All this makes it possible to increase the probability of hitting targets and ensure firing at all types of low-flying targets, including cruise missiles. The S-125 Pechora-2 complex can have both stationary and mobile deployment options. In both cases, the number of launchers relative to the original

Зоны поражения ЗРК «Печора» и «Печора-2»

SAM systems have been increased from 4 to 8. Deployment time has been reduced from 90 to 30 minutes, which is comparable to that of the American Patriot complex. As a transport-launcher chassis for

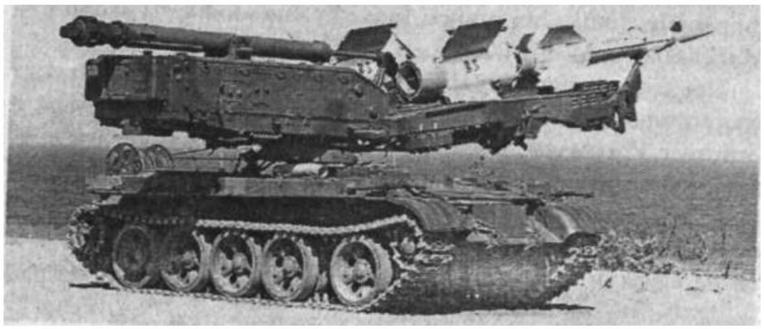
various versions of the modified S-125 air defense system, two variants of off-road wheeled chassis (6x6 wheel arrangement) from the Minsk Wheel Tractor Plant are offered - MZKT-8021 and MZKT-8002.

It is planned to modernize the S-125 air defense systems in service with Egypt. According to the Camp David Peace Treaty between Egypt and Israel, Egypt is only allowed to modernize its existing air defense systems, and not to purchase new ones. Of all the air defense systems supplied to Cairo by the Soviet Union (S-75MZ, “Cube” / “Kvadrat”, S-125M1), the Egyptians preferred the latter.

TACTICAL AND TECHNICAL CHARACTERISTICS

	S-125 "Pechora"	"Pechora-2"
Deployment (collapse) time at position, min	more than	up to
Number of launchers Number of target	90 to 4	30 to 8
channels: with one CNV with two CNV Possibility	one	one
of receiving and		two
processing automated information about targets from the CP and CPU,	not provided	provided up to 16 targets
Distance between the control cabin (UCC) and the center of the position, m up to 20.0 Maximum distance		up to 150.0
from the launcher up to 0.07 to the control cabin (km)		up to 10.0
The ability to detect and track a target using a teleoptical channel:		
during the day at night	is provided is provided	is not provided is provided
in the IR range (thermal imager)	not provided	provided
Possibility of operation of the complex in conditions of passive interference	limited	provided
Ability to work in conditions of active interference	limited	provided
Number of parameters checked during maintenance	. over 400	up to 80
number of spare parts and accessories, pcs.	over 3000	up to 300

S-125 "Neva-SC" (POLAND)



The S-125 Newa-SC self-propelled anti-aircraft missile system is designed to engage air targets at low and medium altitudes. The complex is all-weather and is capable of firing at targets on a collision course and in pursuit. In exceptional cases, the complex can fire at radar-observed ground and surface targets. The complex was developed within the framework of the "Concept for the Development of the Armed Forces until 2012" adopted in the late 90s by the government of the Republic of Poland.

The air defense system was developed on the basis of the Russian-made S-125 system. The first stage of modernization of the Neva was undertaken in 1992 in Torun; until that time, the Russian manufacturer did not agree to any design changes. The stage consisted of installing the launcher on the chassis of

the T-55 tank, and the antenna system, which is part of the air defense system, was placed on a wheeled chassis from the Scud missile system (MAZ type). There is an opportunity to create a complex

self-propelled

The next stage of modernization began in 1996. With the exception of missiles, almost everything in the Neva complex was replaced. The concept and modernization project were made by engineers of the Military Engineering Academy. Also took part in the work

specialists from the air defense forces and scientists. The base was the city of Zelonets. The new Neva-SC complex (System Cyfrowy - digital system) has two processors for processing information about the course of targets and missiles, which are also designed to combat interference. Their computing performance is equal to several thousand ordinary computers. They allow you to detect an air target even in a difficult jamming environment.

Modernization has made it possible to increase the target detection range. The damage range remained the same, since it is mainly determined by the power of the motor unit.

The rocket was new, but it was not modernized.

In the old Neva, transmission and reception equipment occupied more than ten cabinets. After modernization it takes only 1 m^3. The display system has been changed. The four monitors required by target tracking operators have been replaced with one. It digitally displays information from both radar and television channels. Instead of manually tracking the target, a joystick is used. The guidance officer's monitor has an additional screen with the ability to switch display modes. The choice of operating mode for radar equipment when combating interference has been simplified.

As a result of the modernization, the staff of the SNR crew and the number of tractors such as KrAZ and ZIL, which served as a means of traction, were reduced by half. The Neva-SC air defense system is equipped with new training equipment and there is no need to have a special training cabin. The air defense system receives information about the air situation from a range of up to 300 km from the Polish-made NUR reconnaissance station, which belongs to the

to the next generation.

The launcher and antenna system do not require precise leveling. The guidance equipment takes into account leveling errors and automatically makes corrections for the angle of deviation. This is especially important when the complex will operate on rough terrain and in winter. By-

it became possible to transport additional missiles on launchers (before that, special transport-loading vehicles were used). This allows

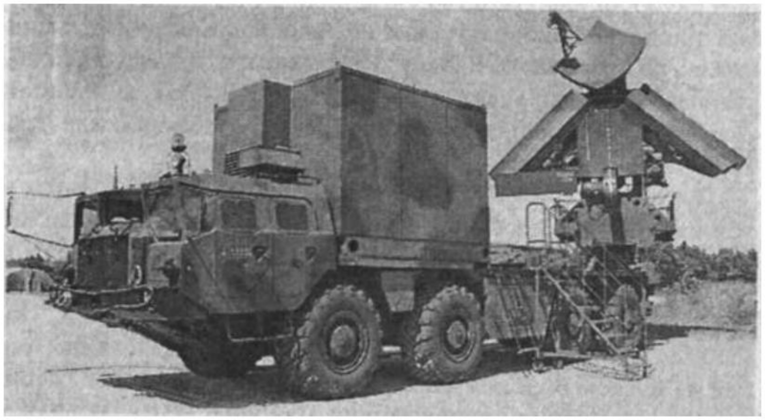
quickly escape enemy attack by 2-3 km, quickly turn around and immediately begin combat operations. Design solutions of the Neva (i.e. processing of target and missile tracking signals, training equipment)

are completed at a modern technical level. The modernization of the Neva air defense system covered almost all of its elements, except for the antenna system and the missiles themselves. Most Great efforts have been made to increase the maneuverability of commercial vehicles. plexa. This is done by installing launchers on the chassis. Although initially they tried to install the Neva on tracked chassis, the final version was a wheeled chassis on which R-300 Scud missiles were placed. However, there is still a possibility of launchers being installed

installations on tracked chassis, since there are many outdated chassis and there is a repair base.

According to the developers, the modernized Neva will be an effective weapon until 2015. In particular, the efficiency and rate of fire of the complex have increased. The modernization made it possible to reduce the number of launchers in the division from four to three (4 combat-ready missiles each) and at the same time increase the number of transported missiles to eight. A reduction in the number of air defense missile systems has been achieved - only 11. The new Neva is more resistant to interference and, as the first own air defense system, received its own

new state identification system produced



"Neva-SC" on a wheeled chassis

under license from Thomson-CSF. Computerization and simplification of maintenance made it possible to reduce the composition of the combat crew of the air defense system. To calculate the SNR, the staff decreased from 22 to 6 people. The combat crew is 3 people, 2 less than before. The disadvantage is the old antenna, which significantly limits the combat capabilities of the complex. Limited financial resources have a decisive influence on this

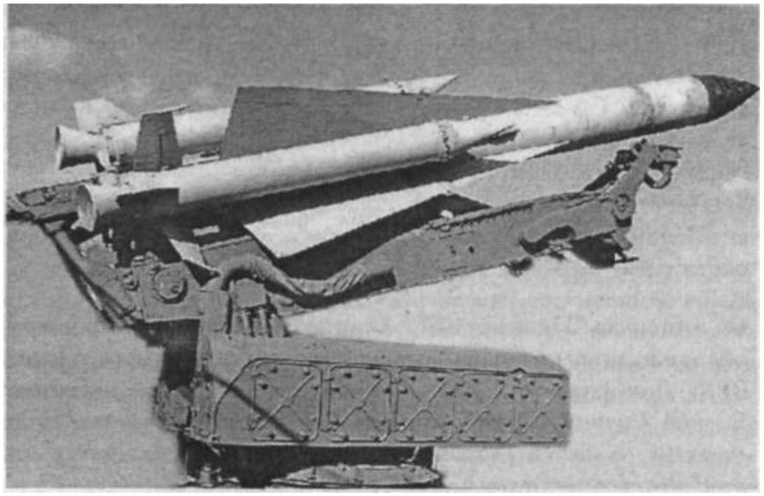
possibilities.

A modern antenna would improve the combat capabilities of the Neva, but equipment of this class of weapons is expensive and is not produced in Poland. Financial reasons led to

refusal to modernize missiles.

The new Neva could become a Polish breakthrough in arms exports. The complex is one of the most widespread in the world, like the American Hawk air defense system. It is believed that about 1200 S-125 air defense systems were produced.

S-200
"Angara", "Vega", "Dubna"
(RUSSIA)



Long-range anti-aircraft missile system S-200 (SA-5 "Gammon") is designed to combat modern and promising air targets: AWACS aircraft and

control, air reconnaissance-attack elements complexes, high-altitude high-speed reconnaissance aircraft of the SR-71 type, jammers and other manned and unmanned air attack systems in conditions of intense radio countermeasures. Sis-

The theme is all-weather and can be used in various climatic conditions.

Development of the complex began in the 50s at KB-1 (now Almaz). General designer A. Raspletin. The anti-aircraft guided missile was developed at the Fakel design bureau, general designer P. Grushin. The first S-200A (Angara) divisions were deployed from 1963 to 1964. on the outskirts of Tallinn. In

total, 1950 launchers were deployed. However, the beginning of widespread deployment of the S-300 led to a reduction in the number of S-200 divisions to 500 launchers in 1996. During its

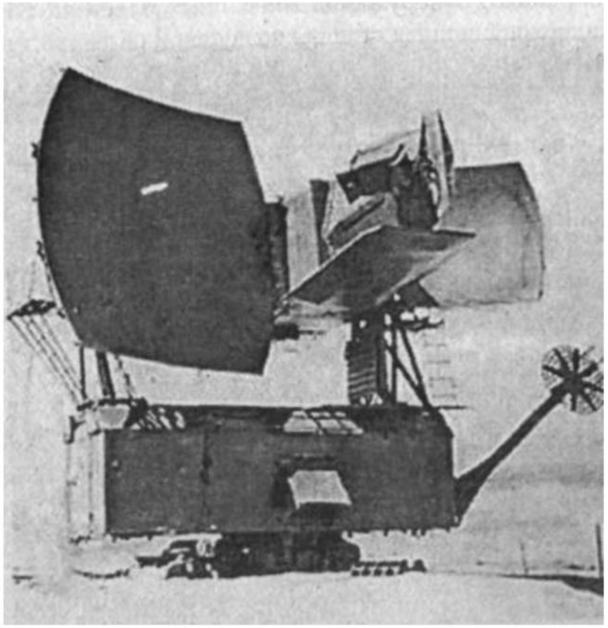
existence of the S-200 air defense system was modernized many times: in 1970 the S-200V ("Vega") entered service and in 1975 - S-200D (Dubna). During the modernization, the firing range and target engagement height were significantly increased (from

20 to 41 km). In

Russia, the S-200 was part of anti-aircraft missile brigades or mixed regiments, which also included S-125 divisions and ZU-23 or S-60 direct cover units.

The main elements of the S-200 anti-aircraft missile system are anti-aircraft missile divisions and anti-aircraft guided missiles. Each division includes a target illumination radar and a starting battery. Anti-aircraft guided missile of the S-200 system is two-stage. The first stage consists of

four solid rocket boosters. The sustainer stage is equipped with a liquid two-component rocket engine. Warhead fragmentation



Target illumination radar

but high explosive. The rocket has a head for semi-active self-guidance

The target illumination radar is a high-potential continuous-radiation radar station. It tracks the target and generates information for launching the missile. In addition, highlight

hits targets during missile homing.

The starting battery has six launchers, which are located in a circle around the ROC. On them there is storage, pre-launch preparation and launch of anti-aircraft rockets.

The S-200 air defense system includes: control and target designation station K-9M, target illumination radar RPTs 5N62V (antenna post K-1V, equipment cabin K-2V), launch battery 5ZH51 (launch preparation cabin K-ZV, launchers 5P72V, charging machines 5YU24M, anti-aircraft guided missiles 5V21V and 5V28), power supplies - diesel power plants.

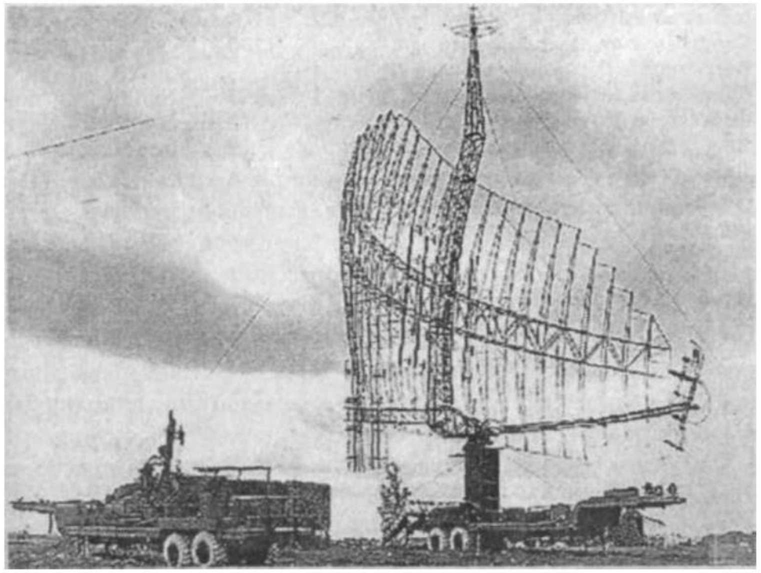
For early detection of air targets, the ZRDN is equipped with an air reconnaissance radar of the P-35 type and others.

Transport vehicle of the S-200 complex

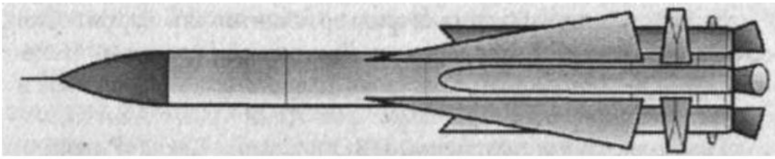
In 1983, the system began to be deployed on the territory of the Warsaw Pact countries: in East Germany, Czechoslovakia and Hungary, which was a consequence of the supply of E-ZA AWACS AWACS aircraft to NATO that began in 1982.

After the defeat of the Syrian air defense in the Bekaa Valley (Libya), 4 S-200 air defense systems were delivered to Syria, which were deployed 40 km east of Damascus and in the northeast of the country. Initially, the complexes were serviced by Soviet crews, and in 1985 they were transferred to the Syrian air defense command. According to some reports, Syrian S-200s shot down an Israeli E-2C Hawkeye aircraft.

The first S-200 systems were delivered to Libya in 1985. Libya formed brigades consisting of two S-200 and two S-125 divisions. In 1986, S-200 divisions, served by Libyan crews, participated in repelling an American air raid on Tripoli and Benghazi, during which the United States lost one F-111 fighter-bomber, and according to Libyan data, several more carrier-based aircraft.



P-14 air reconnaissance radar



At the end of 1987, the S-200s were delivered to North Korea for use as part of the air defense forces. The complexes were capable of defeating E-ZA AWACS, TR-l/U-2, RC-135 aircraft up to the northern borders of South Korea.

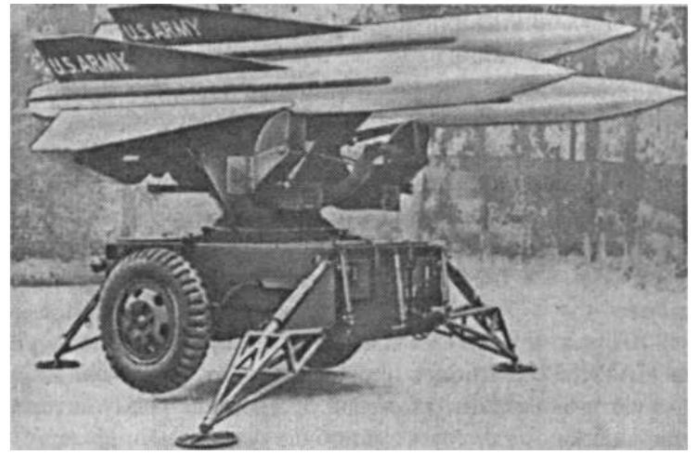
The complex was supplied to Bulgaria, Hungary, India, Iran, North Korea, Libya, Poland, Syria, Czech Republic.

TACTICAL AND TECHNICAL CHARACTERISTICS

	S-200	S-200V	S-200D 1 2
Number of channels per target			
Number of channels per missile	12	12	
Target firing range, km:			
maximum	150	180	240
minimum Damage	17	17	7
height, km:			
maximum	20	35	41
minimum	0.3	0.3	0.05
Target speed, maximum, m/s Probability of	1200	1200	1200
hitting one missile defense system Number of		0.9	
anti-aircraft divisions, pcs. Number of missiles in a	up to	to 5	up
division, pcs. Ready-to-fire time, min Rocket	5	12	
length, m Rocket diameter (main stage), m	12	1.5	to5
Weight, kg: missile	1.5	10.8	12
warhead Folding time, h	10.5 0.86	0.86	1.5 10.8 0.86
		7100	8000
	217	217	217
	24	24	24

"Hawk", "Advanced Hawk"

(USA)



“Hawk” - HAWK (Homming All the Killer) - a medium-range anti-aircraft missile system designed to destroy air targets at low and medium altitudes. Work on the creation of the complex began in 1952. A contract for the full-

scale development of the complex between the US Army and Raytheon was concluded in July 1954. Northrop was to develop a launcher, loader, radar stations and control system . The first experimental launches of anti-aircraft guided missiles were carried out from June 1956 to July 1957. In August 1960, the first Hawk anti-aircraft missile system with the MIM-23A

missile entered service with the US Army. A year earlier, a memorandum was concluded within NATO between France, Italy, the Netherlands, Belgium, Germany and the United States on the joint production of the system in Europe. In addition, a special grant provided for the supply of systems manufactured in Europe to Spain, Greece and Denmark, as well as the sale of systems produced in the USA to Japan, Israel and Sweden. Later in 1968, Japan began joint production of the complex. In the same year, the United States supplied Hawk complexes to Taiwan and South Korea.

In 1964, in order to increase the combat capabilities of the complex, especially to combat low-flying targets, a modernization program called HAWK/HIP (HAWK Improvement Program) or “Hawk-1” was adopted.* It provided for the introduction of a digital processor for automatic processing information about the target, increasing the power of the warhead *(75* kg versus 54), improving the guidance system and propulsion system of the MIM-23 missile. System modernization

provided for use as a lighting station
continuous radiation radar targets, which made it possible to improve missile guidance against the background of signal reflections from the ground.

In 1971, the modernization of the US Army and Navy complexes began, and in 1974, the modernization of NATO complexes in Europe began. In 1973, the US Army began the second phase of

modernization of the HAWK/PIP (Product Improvement Program) or Hawk-2, which took place in three stages. At the first stage, the radar transmitter for detecting continuous radiation was modernized.

radiation in order to double the power and increase the detection range, supplement the pulse detection locator with an indicator of moving targets, as well as connect the system to digital communication lines.

The second stage began in 1978 and lasted until 1983-86. At the second stage, the reliability of the work was significantly improved.
target illumination radar due to the replacement of electrovacuum devices with modern solid-state generators, as well as the addition of an optical tracking system, which made it possible to work in conditions of interference. The main firing unit of the complex after the second phase of modification is a two-platoon (standard) or three-platoon

(reinforced) anti-aircraft battery. Battery

Dart composition consists of the main and advanced fire
platoons, and a reinforced battery - from the main and two forward
out platoons.

A standard battery consists of a TSW-12 battery command post, an MSQ-110 information and coordination center, an AN/MPQ-50 pulse targeting radar,

an AN/MPQ-55 detection radar operating in continuous emission mode, an AN/MPQ;51 radar rangefinder and two fire platoons, each of which consists of an AN/MPQ-57 illumination radar and three Ml92 launchers.

The forward fire platoon consists of an MSW-18 platoon command post, an AN/MPQ-55 continuous wave detection radar, an AN/MPQ-57 illumination radar and three M192 launchers.

The US Army uses reinforced batteries, but many
Other European countries use a different configuration.

Belgium, Denmark, France, Italy, Greece, Holland and Germany have finalized their complexes in the first and second phases. Germany and Holland have installed infrared detectors on their

systems. In total, 93 complexes were modified: 83 in Germany and 10 in Holland. The sensor was installed on the backlight radar between two antennas and is a thermal camera operating in the infrared range of 8-12 microns. It can operate in day and night conditions and has two fields of view. It is assumed that the sensor is capable of detecting targets at ranges of up to 100 km. Similar sensors appeared on complexes being modernized *for* Norway. Thermal cameras can be

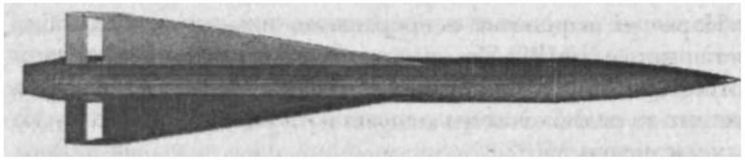
installed on other systems.

The Hawk air defense systems used by the Danish air defense forces were upgraded with television-optical target detection systems. The system uses two cameras: for long ranges - up to 40 km and for search at ranges up to 20 km. Depending on the situation, the illumination radar can be turned on only before launching missiles, i.e., target search can be carried out in passive mode (without radiation), which

increases survivability in conditions of possibility of use
means of fire and electronic suppression.

The third phase of modernization began in 1981 and included the development of Hawk systems for the US Armed Forces. The radar range and battery command post were modified. Field simulator

The TPQ-29 has been replaced by the Joint Operator Trainer.



General view of the MIM-23 missile defense system

During the modernization process, the software was significantly improved, and microprocessors began to be widely used as part of air defense systems. However, the main re-
The result of modernization should be considered the emergence of the ability to detect low-altitude targets through the use of an antenna with a fan-type radiation pattern, which made it possible to increase the efficiency of target detection at low altitudes in conditions of massive raids. Simultaneously from 1982 to 1984. a program for the modernization of anti-aircraft missiles was carried out. The result was the MIM-23C and MIM-23E missiles, which have increased efficiency in interference conditions. In 1990, the MIM-23G missile appeared, designed to hit targets at low altitudes. The next modification was the MIM-23K, designed to combat tactical ballistic missiles. It was distinguished by the use of a more powerful explosive in the warhead, as well as an increase in the number of fragments from 30 to 540. Tests of the rocket were carried out in May 1991.

By 1991, Raytheon had completed the development of the training food for training operators and technical personnel.
The simulator simulates three-dimensional models of a platoon command post, illumination radar, and detection radar and is intended for training officers and technical personnel. To train technical personnel, various situations are simulated for setting up, adjusting and replacing modules, and for training operators, real scenarios of anti-aircraft combat are simulated. US allies are ordering the modernization of their systems in the third phase. Saudi Arabia and Egypt have
signed contracts to modernize their Hawk air defense systems.

During Operation Desert Storm, the US military deployed Hawk air defense systems.

Norway used its own version of the Hawk, called the Norwegian Adapted Hawk (NOAH). Its difference from the main version is that launchers, missiles and target illumination radar are used from the basic version, and a three-dimensional radar is used as a target detection station

AN/MPQ-64A. Tracking systems also include infrared passive detectors. In total, by 1987, 6 NOAH batteries had been deployed to protect airfields.

Between the early 70s and early 80s, the Hawk was sold to many countries in the Middle and Far East. To maintain the combat readiness of the system, the Israelis upgraded the Hawk-2 by installing teleoptical target detection systems (the so-called super eye), capable of detecting targets at a range of up to 40 km and identifying them at ranges of up to 25 km. As a result of modernization, the upper limit of the affected area was also increased to 24,384 m. As a result, in August 1982, at an altitude of 21,336 m, a Syrian MiG-25R reconnaissance aircraft was shot down, making a reconnaissance flight north of Beirut.

Israel became the first country to use the Hawk in combat: in 1967, Israeli air defense forces shot down their fighter. By August 1970, 12 Egyptian aircraft were shot down with the help of the Hawk, of which 1 Il-28, 4 SU-7, 4 MiG-17 and 3 MiG-21.

During 1973, the Hawk was used against Syrian, Iraqi, Libyan and Egyptian aircraft and was shot down 4 MiG-17S, 1 MiG-21, 3 SU-7S, 1 Hunter, 1
"Mirage-5" and 2 MI-8 helicopters. The
next combat use of the Hawk-1 (which had gone through the first phase of modernization) by the Israelis occurred in 1982, when a Syrian MiG-23 was shot down. By March 1989, Israeli air defense
forces had shot down 42 Arab aircraft, using the Hawk, Advanced Hawk and Chaparrel complexes.

The Iranian military has used the Hawk against the Iraqi Air Force several times. In 1974, Iran supported the Kurds in the uprising against Iraq, using Hawks to shoot down 18 targets, followed by more in December of the same year.

2 Iraqi fighters making reconnaissance flights over Iran. After the 1980 invasion and until the end of the war, Iran is believed to have shot down at least 40 armed aircraft.

marriage.

France deployed one Hawk-1 battery to Chad to protect the capital, and in September 1987 it shot down one Libyan Tu-22 attempting to bomb the airport.

Kuwait used Hawk-1s to fight Iraqi planes and helicopters during the invasion in August 1990. Fifteen Iraqi planes were shot down. Until 1997, the Northrop company produced 750 transport-loading vehicles, 1,700 launchers, 3,800

missiles, and more than 500 tracking systems. To increase the effectiveness of air defense, the Hawk air defense system can be used in conjunction with the Patriot air defense system to cover one area. To achieve this, the Patriot's

command post was upgraded to allow control of the Hawk. The software was modified in such a way that when analyzing the air situation, the priority of targets was determined and the most appropriate missile was assigned. In May 1991, tests were carried out, during which the command post of the Patriot air defense system demonstrated the capabilities of detecting tactical ballistic missiles and issuing target designation to the Hawk air defense system.

efforts to destroy them.

At the same time, tests were carried out on the possibility of using the AN/TPS-59 three-dimensional radar, specially upgraded for these purposes, to detect tactical ballistic missiles of the SS-21 and Scud types. To achieve this, the viewing sector along the angular coordinate was significantly expanded from 19° to 65°, the detection range for ballistic missiles was increased to 742 km, and the maximum altitude was increased to 240 km. To defeat tactical ballistic missiles, it was proposed to use the MIM-23K missile, which has a more powerful warhead and a modernized fuse. The HMSE modernization program (HAWK Mobility, Syrvi-vability and Enhancement), designed to increase the mobility of the complex, was implemented in the interests of the naval forces from 1989 to 1992 and had four main

peculiarities. Firstly, the launcher was modernized. All electric vacuum devices have been replaced with
integrated circuits, micro-
processors. This made it possible to improve combat characteristics and provide a digital communication line between the launcher and the platoon command post. The modification made it possible to abandon heavy multi-core control cables and replace them with a regular telephone pair.

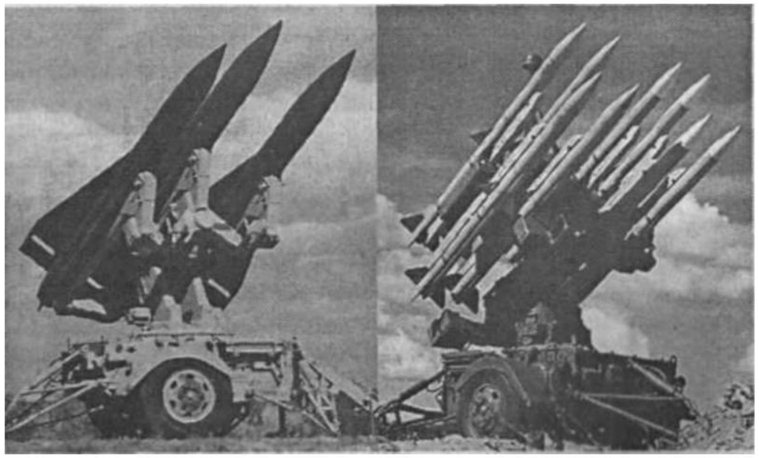
Secondly, the launcher was modernized in such a way as to provide the possibility of redeployment (transportation) without removing missiles from it. This significantly reduced the time it took to bring the launcher from a combat position to a traveling position and from a traveling position to a combat position.

by eliminating time for reloading missiles.

Thirdly, the starting hydraulics were modernized
installation, which increased its reliability and reduced energy consumption. Fourthly, a system of automatic

orientation on gyroscopes using a computer was introduced, which made it possible

eliminate the operation of orienting the complex, thereby reducing the time it takes to bring it into combat position. Conducted
modernization made it possible to halve the number of transport units when changing position, to more than halve the time for transferring from traveling to combat position, to increase



Launcher with MIM-23 missiles PU with AMRAAM missiles

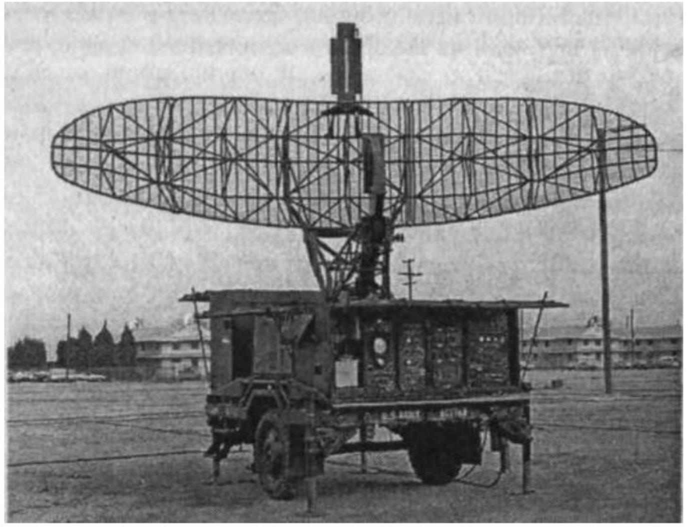
increase the reliability of the launcher electronics by 2 times. Except In addition, the upgraded launchers are prepared for the possible use of Sparrow or AMRAAM missiles. The presence of a digital computer as part of the launcher made it possible to increase the possible distance of the launcher from the platoon command post from 110 m to 2000 m,

which increased the survivability of the complex.

The Hawk MIM-23 air defense missile does not require testing or maintenance in the field. *To* check the combat readiness of missiles, random checks are periodically carried out using special equipment.

The rocket is single-stage, solid propellant, designed according to the “tailless” design with a cruciform arrangement of wings. The engine has two levels of thrust: during the acceleration phase - with maximum thrust and subsequently - with reduced thrust.

To detect targets at medium and high altitudes, the AN/MPQ-50 pulse radar is used. The station is equipped with noise protection devices. Analysis of the interference situation before emitting a pulse allows you to select a frequency that is free from enemy suppression. Continuous wave radar is used to detect targets at low altitudes



AN/MPQ-50 target reconnaissance station

AN/MPQ-55 or AN/MPQ-62 (for air defense systems after the second phase of modernization). Radars use a continuous linear frequency modulated signal and measure the azimuth, range and speed of the target. The radars rotate at a speed of 20 rpm and are synchronized in such a way as to eliminate the appearance of blind areas. The radar for detecting targets at low altitudes, after modification in the third phase, is capable of determining the range and speed of a target in one viewing. This was achieved by changing the shape of the emitted signal and using a digital signal processor using fast Fourier transform. The signal processor is implemented on a microprocessor and is located directly in the low-altitude detector. The digital processor performs many of the signal processing functions formerly performed in the battery signal processing station and transmits the processed data to the battery command station over a standard two-wire telephone line. The use of a digital processor made it possible to avoid the use of bulky and heavy cables between the low-altitude detector and the battery

command post.

The digital processor correlates with the interrogator’s “friend or foe” signal and identifies the detected target as an enemy or as its own. If the target is an enemy, the processor issues target designation to one of the fire platoons to fire at the target. In accordance with the received target designation

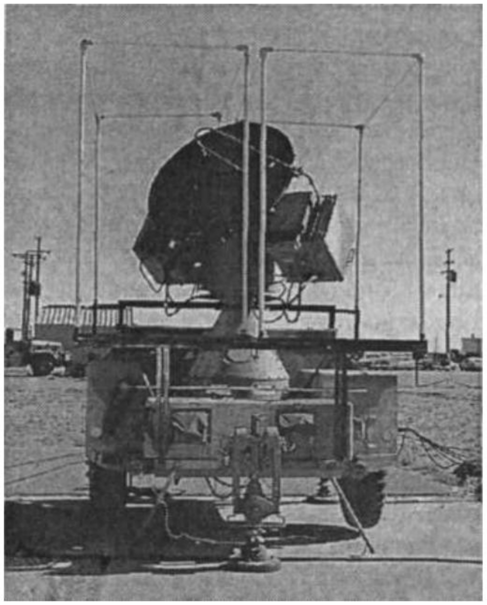
The target illumination radar turns in the direction on the target, searches for and captures the target for tracking. The illumination radar is a continuous radiation station and is capable of detecting targets at speeds of 45-1125 m/s. If the target illumination radar is unable to detect

range to the target due to jamming, then it is determined is possible using AN/MPQ-51 operating in the range 17.5-25 GHz. The AN/MPQ-51 is used only to determine the missile launch range, especially when suppressing the AN/MPQ-46 (or AN/MPQ-57B depending on the stage of modernization) range channel and pointing the missile defense system at the source of interference. Information about the coordinates of the target is transmitted to the launcher selected for firing at the target. Launcher

The aircraft turns towards the target, and pre-launch preparation of the rocket occurs. After the rocket is ready for launch, the control processor provides lead angles through the illumination radar, and the rocket is launched. The signal reflected from the target by the homing head is captured, as a rule, before the missile is launched. The missile is aimed at the target using the proportional approach method; guidance commands are generated by a semi-active homing head using the monopulse principle

locations.

In the immediate vicinity of the target, a radio fuse is triggered and the target is covered with fragments of a high-explosive fragmentation warhead. The presence of fragments leads to an increase in the probability of hitting a target, especially when shooting at group targets. After the warhead is detonated, the battery combat control officer evaluates the firing results using a Doppler target illumination radar in order to make a decision to fire at the target again if it is not hit by the first missile.

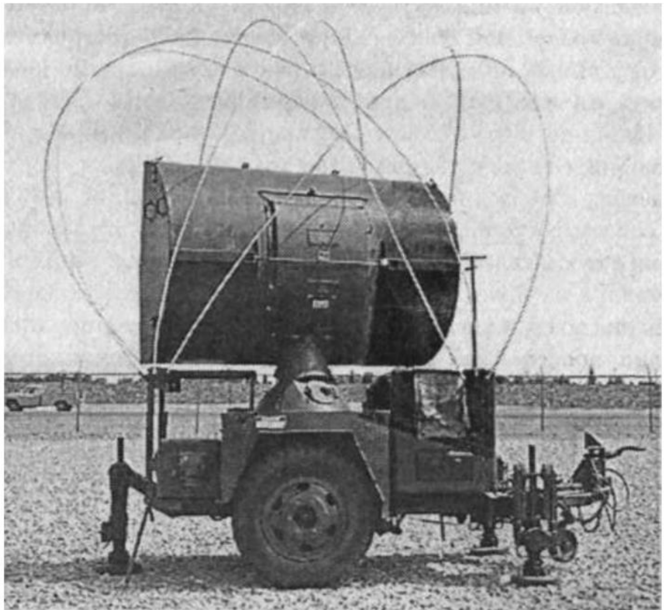


Radar rangefinder AN/ MPQ-51

The battery command post is designed to control the combat operations of all components of the battery. General control of combat work is carried out by a combat control officer. He manages all battery command post operators. The assistant combat control officer assesses the air situation and coordinates the actions of the battery with a higher command post. The combat control panel provides these two operators with information about the state of the battery and the presence of air targets, as well as data for firing targets. To detect low-altitude targets, there is a special "azimuth-speed" indicator, which only receives information from the continuous radiation detection radar. Manually selected targets are assigned to one of two fire control operators. Each operator uses the fire control display to quickly acquire radar target illumination and control

launchers.

The information processing point is designed for automatic data processing and communication of the computer battery



РЛС обнаружения маловысотных целей AN/MPQ-55

lexa. The equipment is placed inside a cabin mounted on a single-axle trailer. It includes a digital device for processing data received from both types of target designation radars, friend-or-foe identification equipment (the antenna is mounted on the roof), interface devices and

means of communication.

If the complex is modified in accordance with the third phase, then there is no information processing point in the battery and its functions are performed by modernized battery and platoon command posts. The platoon command post is

used to control the firing of the fire platoon. It is also capable of solving the tasks of an information processing point, which is similar in equipment composition, but is additionally equipped with a control panel with an all-round visibility indicator and other display means and controls. The combat crew of the command post includes the commander (fire control officer), radar and communications operators. Based on information about targets received from the target designation radar and displayed on the all-round display, the air situation is assessed and the target to be fired is assigned. Target designation data on it and the necessary commands are transmitted to the illumination radar of the forward fire platoon.

The platoon command post, after the third phase of modification, performs the same functions as the command post of the forward fire platoon. The modernized command post has a crew consisting of a radar operator control officer and a communications operator. Some of the electronic equipment of the point has been replaced with new ones. The air conditioning system in the cabin has been changed, the use of a filter ventilation unit

A new type of innovation makes it possible to prevent the penetration of radioactive, chemically or bacteriologically contaminated air into the cabin. Replacing electronic equipment involves using high-speed digital processors instead of outdated components. Due to

The use of microcircuits has significantly reduced the size of memory modules. The indicators have been replaced with two computer displays. Bidirectional digital communication lines are used to communicate with detection radars. IN

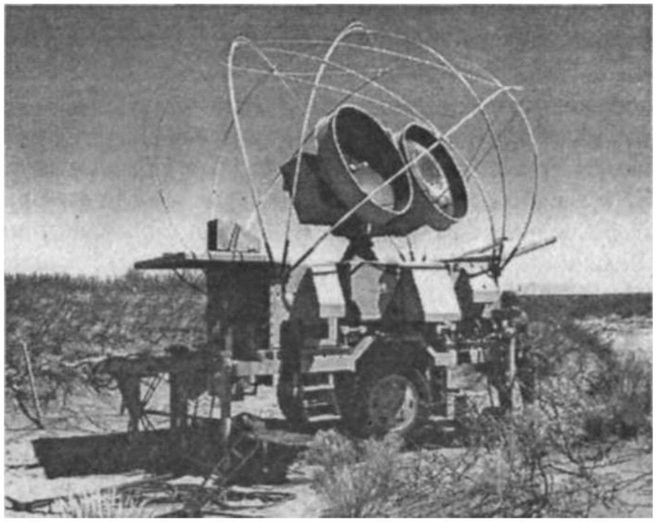
The platoon command post includes a simulator that allows you to simulate 25 different raid scenarios for crew training. The simulator is capable of reproducing and

various types of interference.

The battery command post, after the third phase of modification, also serves as an information and coordination center, so the latter is excluded from the complex. This made it possible to reduce the combat crew from six people to four. The command post includes an additional computer placed in a digital computer rack.

The target illumination radar is used to capture and track the target designated for firing in range, angle and azimuth. Using a digital processor, angle and azimuth data are generated for the target being tracked.

to turn three launchers towards the target. To guide the missile to the target, the energy of the illumination radar reflected from the target is used. The target is illuminated by the radar throughout the entire missile guidance phase until the firing results are assessed. To search and capture a target, the illumination radar receives target designation from the battery command post.



AN/MPQ-46 circuit illumination radar

After the second phase of refinement, the following changes were made to the out-of-the-way illumination radar: an antenna with a wider radiation pattern makes it possible to illuminate a larger area of space and fire at low-altitude group targets; an additional computer allows the exchange of information between the radar and the platoon command post via two-wire digital communication lines.

For the needs of the US Air Force, Northrop company for radar for target illumination, installed a television optical system mu, which allows you to detect, track and recognize air targets without emitting electromagnetic energy. The system operates only during the day, both with and without a locator. The teleoptic channel can be used -

to evaluate the results of shooting and to track a target in conditions of interference. The teleoptical camera is installed on a gyro-stabilized platform and has a 10x magnification. Later, the teleoptical system was modified to increase the range and improve the ability to track a target in fog. The possibility of automatic search has been introduced. The teleoptical system has been modified with an infrared channel. This made it possible to use it day and night. The teleoptical channel was completed in 1991, and field tests were carried out in 1992.

For the Navy complexes, the installation of a teleoptical channel began in 1980. In the same year, the delivery of systems for export began. About 500 sets were produced until 1997

for installation of teleoptical systems.

The AN/MPQ-51 pulse radar operates in the range of 17.5-25 GHz and is designed to provide target illumination to the radar when the latter is suppressed by interference. If the complex is modified in the third phase, the range finder

excluded.

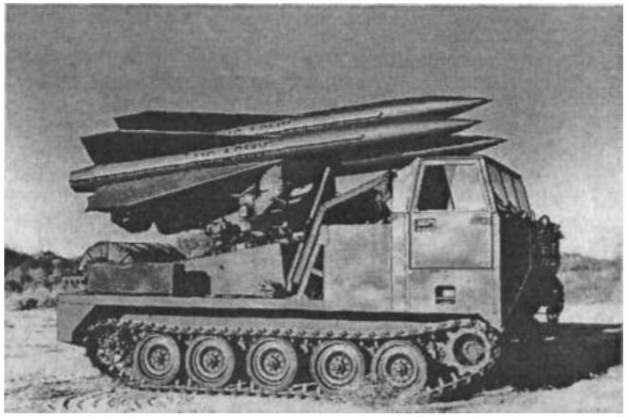
The M-192 launcher stores three missiles ready for launch. Missiles are launched from it at a set rate of fire. Before launching a missile, the launcher is deployed in the direction of the target, voltage is applied to the missile to spin up the gyroscopes, the electronic and hydraulic systems of the launcher are activated, after which the

The rocket engine starts.

In order to increase the mobility of the complex for the US Army ground forces, a version of the mobile complex was developed. Several platoons of the complex were modernized. The launcher is located on the M727 self-propelled tracked chassis (developed on the basis of the M548 chassis), and it also houses three missiles ready for launch. At the same time, the number of transport units decreased from 14 to 7 due to the possibility of transporting missiles on the launcher and replacing the M-501 transport-loading vehicle with a vehicle equipped with a hydraulically driven lift based on a truck. On the new TZM and its trailer could-

can be transported on one rack with three missiles on each. At the same time, the deployment and collapse time was significantly reduced. Currently, they remain in service only in the Israeli army. The Hawk-Sparrow demonstration project is a combination of elements produced by Ray-Theon. The launcher has been modified so that instead of 3 MIM-23

missiles, it can accommodate 8 Sparrow missiles. In January 1985, field tests of the modified system were conducted at the California Naval Test Center. Sparrow missiles hit two remotely piloted aircraft. Typical fire platoon composition



Launcher on the M727 self-propelled tracked chassis

The Hawk-Sparrow includes a pulse detection locator, a continuous radiation detection radar, a target illumination radar, 2 launchers with MIM-23 missiles and 1 launcher with 8 Sparrow missiles. In a combat situation, launchers can be converted to either Hawk or Sparrow missiles by replacing ready-made digital blocks on the launcher. One platoon can contain two types of missiles, and the choice of missile type is determined by the specific parameters of the target being fired. Hawk missile loader

and the missile pallets are eliminated and replaced with a transport truck with a crane. On the truck drum there are 3 Hawk missiles or 8 Sparrow missiles, placed on 2 drums, which reduces loading time. If the complex is transported by a C-130 aircraft, then it can carry a launcher with 2 Hawk or 8 Sparrow missiles, fully ready for combat use. This significantly reduces the time it takes to get into combat readiness.

The complex was supplied and is in service in the following countries: Belgium, Bahrain (1 battery), Germany (36), Greece (2), the Netherlands, Denmark (8), Egypt (13), Israel (17), Iran (37), Italy (2), Jordan (14), Kuwait (4), South Korea (28), Norway (6), UAE (5), Saudi Arabia (16), Singapore (1), USA (6), Portugal (1), Taiwan (13), Sweden (1), Japan (32).

Loading PU

Demonstration project "Hawk-AMRAAM"

In 1995, demonstration firing of AMRAAM missiles was carried out from modified M-192 launchers, using the standard battery radar composition. Externally, the PU has 2 drums, similar to the Hawk-Sparrow.

DETECTION RANGE OF THE COMPLEX RADAR (after the first phase of modification), km

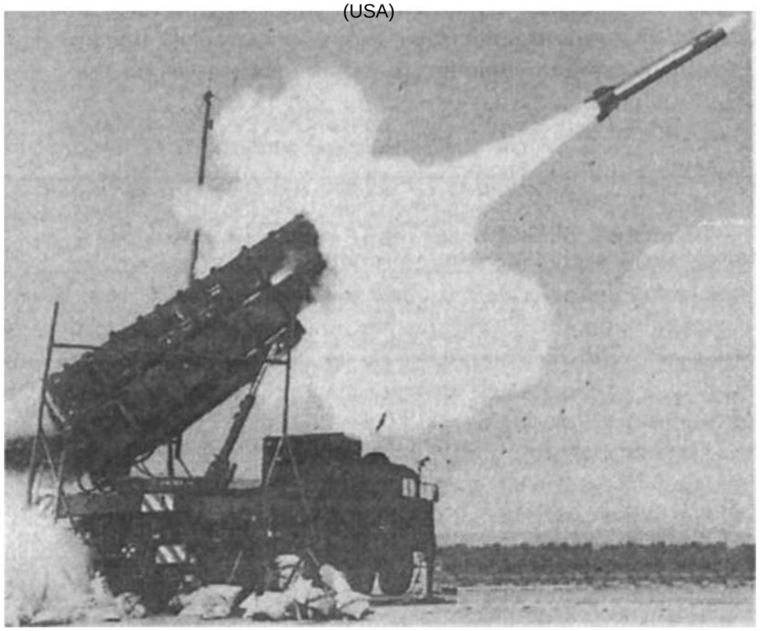
Effective reflective target surface, m2	AN/MPQ-48 Pulse detection radar	AN/MPQ-48		AN/MPQ-46 Radar target illumination	AN/MPQ-51 Rangefinder
		cont. radiation	frequency modular		
	72—79	52	48	72—75	63
1	90—98	65	60	89—93	78
2.4 3	96—104	69	63	93—99	83

TACTICAL AND TECHNICAL CHARACTERISTICS

	MIM-23A	MIM-23B
Maximum engagement range, km:		
high altitude target	32	40
low altitude target	16	20
Minimum engagement range, km:		
high-altitude target		1.5
low-altitude target Damage	2 3.5	2.5
height, km:		
maximum	13.7	17.7
minimum	0.06	0.06
Rocket length, m	5.08	5.08
Rocket diameter, m	0.37	0.37
Wingspan, m Weight, kg:	1.19	1.19
missile	584	627.3
warhead	54	75
Maximum speed, M	2.7	2.7

"Patriot"

(USA)



The Patriot medium-range air defense system is designed to destroy operational-tactical aircraft and ballistic missiles at low, medium and high altitudes in conditions of strong electronic countermeasures from the enemy. Development of the complex began in 1963 to replace the previous generation Nike Hercules and Hawk air defense systems. The main criteria that guided its creators were the requirements for a minimum number of personnel and equipment to reduce life cycle costs, as well as achieving the characteristics necessary to repel airborne threats expected in subsequent years.

decades.

In October 1964, requirements for the system, which at that time had the designation SAM-D (Surface-to-Air Missile-Development), were prepared, and three companies - Raytheon, Hughes and RCA - began on a competitive basis to develop it

main components. In May 1967, Raytheon was selected as the lead developer of this system. The development of the rocket was entrusted to the Martin-Marietta concern. The first flight test of the missile took place in February 1970 (according to other sources - in November 1969), and on January 11, 1974, the missile performed guidance maneuvers for the first time based on commands coming from a ground-based radar. In total, during the development of the basic version of the SAM-D air defense system, more than 125 missile launches were carried out. In 1982, the SAM-D, called "Patriot," entered service with the US Army. However, at the initial stage of

operation, a number of shortcomings were identified

both technical and programmatic, which were subsequently eliminated. *In order* for the combat capabilities of the air defense system to correspond to the level of development of the means of

stifling attack, there was a program to modernize the complex for the period until 2000. The main organizational and tactical unit

of air defense missile systems is a division, which includes six fire stations and one headquarters battery. The main fire unit is the battery. It is capable of simultaneously firing at up to eight air targets. It consists of a fire control command post

AN/MSQ-104, multifunctional radar AN/MPQ-53 with phased array antenna, eight launchers with MIM-104 anti-aircraft guided missiles in transport and launch containers, MRC-137 radio relay stations, power supply and maintenance facilities. The MGM-104 Patriot single-stage missile defense system is designed according to a normal aerodynamic design. Its warhead

is high-explosive fragmentation (weight 90.7 kg). Solid propellant engine, single-mode, medium thrust. 11,000 kg works for 11.5 s, giving the rocket a speed of 1750 m/s. The total weight of the Patriot missile defense system is 906 kg. The rocket is designed for an overload of up to 30 g.

Under the nose fairing there is a flat radar antenna with a diameter of 305 mm, consisting of a guidance unit in the final section (TS-6) and a modular guidance unit in the middle section (MMR). The MMR block is located in the warhead and contains navigation equipment and

tow computer. An inertial unit, auxiliary electronic equipment, a signal converter, a safety actuator, antennas and a warhead are also installed here. The missiles are placed in transport and launch containers, closed at the front and back with elastic

lids.

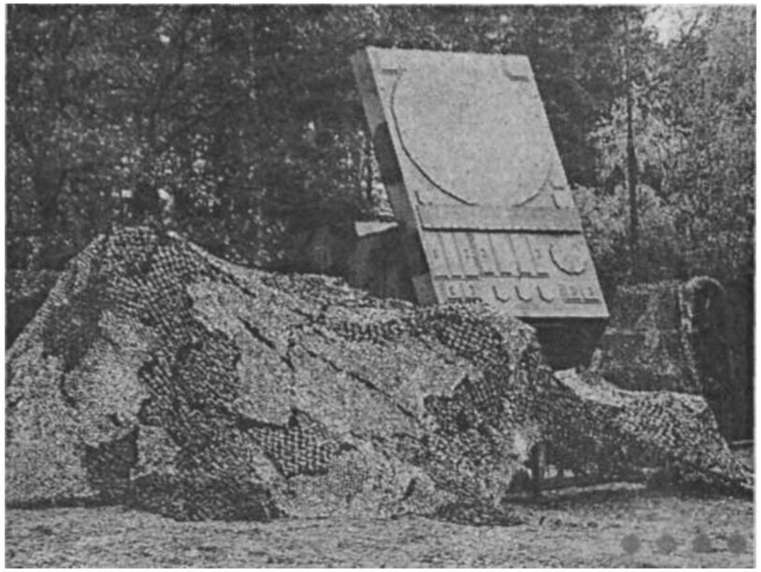
The battery command post is designed to collect, accumulate and process all information necessary for the operation of the air defense system, as well as to control the operation of the radar AN/MPQ;53 and missile guidance. It is located in a car van and has two duplicate specialized digital computers that control the radar and the missile in flight, control units for radiation frequencies and movement of radar antenna beams, two indicators with control panels for the operation of the entire air defense system, and communication equipment with other elements of an air defense system (VHF radio relay station MRC-137 with digital

Anti-aircraft guided missile MIM-104

new data transmission line "Link-1"). Its equipment provides automatic control of the entire range of air defense systems related to the interception of air targets. The presence of two indicators allows for the final

At the first stage of missile guidance, display on one of them the radar situation that the missile “sees” as it approaches the target. This method in the foreign press is called TVM (Target-Via-Missile) - guidance through a missile. The fire control command post is served by two operators.

The multifunctional radar AN/MPQ-53 is designed to search, detect, identify and track air targets and missiles, and transmit control commands to them. To identify targets, the integrated interrogator AN/TPX-46(V)7 is used. Depending on the operating mode of the station, the radar transmitter generates microwave signals of different types, duration and repetition rate, power and operating frequency, which are transmitted through a waveguide to the irradiating horn. The transmitter uses 160 fixed operating frequencies belonging to the 4-6 GHz range. Choice


Multifunctional radar AN/ MPQ-53

this range is due to the multifunctionality of the radar AN/MPQ-53.

The radar is installed in the direction of the expected threat and maintains this position during the shooting process. The azimuth direction of the antenna can be changed during breaks between reflect the raids remotely: on command from the control point by rotating the entire radar relative to the semi-trailer. The station's antenna system includes seven phased antenna arrays (PAA) and an identification station antenna. The main purpose of the phased array is the emission

and reception of signals in the airspace survey mode, detection of targets and their subsequent tracking, emission of a target illumination signal for the operation of a semi-active missile homing head, transmission of control commands on board the missile. The diameter of the main array is 2.44 m. It consists of 5160 antenna elements of the same type. The second largest phased array can only receive information from the rocket. Structurally, it consists of 251 antenna elements and is located below and to the right of the main phased array. The remaining five (51 elements each) are side-lobe compensator antennas, designed to reduce the effectiveness of the enemy's active interference on the radar. The viewing sector in search mode is in azimuth - from +45 to -45° and in elevation - 1-73°. The tracking sector in the guidance mode through the missile in azimuth is from *+55* to -55°, and in elevation – 1–83°. Detection range with a probability of 0.9 with an effective reflective target surface of 0.1 m^2

(the head part of the rocket) is 60-70 km, at 0.5 m^2 (missile) - 85-100 km, at 1.5 m2 (fighter) - PO - 130 km, at Yum2 (bomber) - 160-190 km. Target detection time is 8-10 s.

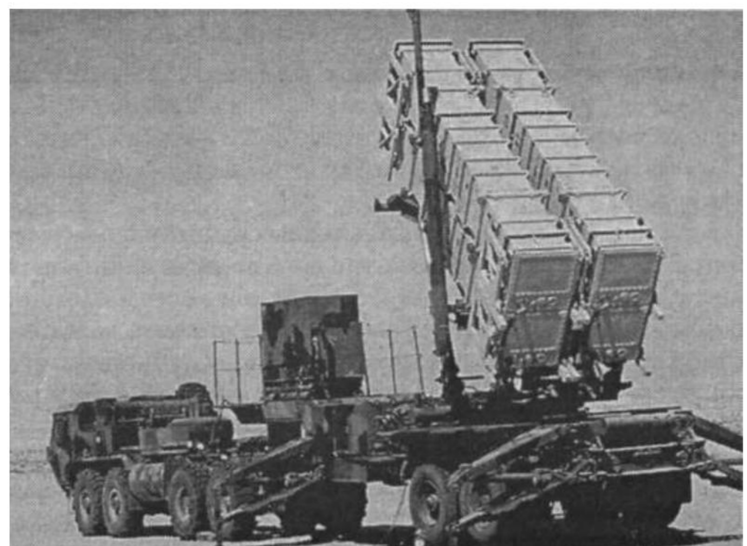
The AN/MPQ-53 multifunctional radar is mounted on a two-axle semi-trailer weighing 15 tons and transported by an M818 wheeled tractor. The launcher is placed on a two-axle

heavy-duty trailer (it is served by a crew of three people). It can move with missiles in containers along roads and over rough terrain, and can also be transported by transport aircraft. On one launcher there are four

three missiles in transport and launch containers. Each installation is capable of providing their single launches. At the firing position, the launcher is located at a distance of up to 1 km from the command post and radar. Communication with the fire control command post is carried out via a data line and radiotelephone. The launcher allows you to rotate the missile defense system in the container in azimuth within the range from +110 to -110° relative to its longitudinal axis. The missile launch angle is fixed - 38° from the horizon line. Sealed containers make it possible to avoid checking missiles in the field and reduce the number of rounds.

serving personnel.

The main method of controlling the combat operations of Patriot air defense missile systems is centralized. With it, all decisions to fire at air targets, except for self-defense, are made at the division command post, where joint processing of information received at the battery fire control command post is carried out. The division's command post is connected to the command post of neighboring divisions and groups (brigades) of air defense systems using the TSQ-73 Missile Minder automated control system. This significantly increases the ability to fire batteries in a difficult jamming environment.



Пусковая установка M901

Target designation data can also be supplied to the battery fire control command post directly from the Nage system control centers, from the TSQ-73 automated control system or the AWACS (E-3) system. With decentralized control, decisions are made at the battery command post under control from the division command post, which can interfere with the course of combat work. In the event of failure (due to suppression of interference) of the radio relay data transmission line, the battery performs combat missions in autonomous mode according to information received from the radar

AN/MPQ-53. Data is exchanged between the battery fire control command posts about the targets being tracked, the progress of the interception, and the results of the shooting.

The guidance system for the Patriot missile defense system is combined. In flight, the missile is guided according to commands, and when approaching the target, the guidance method through the rocket is used. The guidance system uses the AN/MPQ-53 radar, operating in the range of 5.5-6.7 cm. The Patriot missile defense system operates as follows. The multifunctional radar searches, detects, identifies

and determines the coordinates of targets. As dangerous targets approach the interception line

the forward meeting points are calculated and accepted decision to launch missiles. All operations are performed at the fire control center automatically using a digital computer, and data on the firing order is displayed on the indicator screen. When the target approaches a certain line, the launcher turns in azimuth to the pre-empted meeting point and launches the missile. If the target is single and located at a considerable distance from the protected object, then one missile is launched. If there are several targets, and they are flying

in a dense combat formation and are at such a distance that it is impossible to launch according to the "launch-evaluate-results-launch" principle, the missiles are launched sequentially so that they approach a dense group of targets with an interval of 5-10 s (depending on the altitude of their flight). If there are one or more group goals that carry out

flying in open formation, two missiles should not approach them at the same time to allow enough time

to illuminate the "target-missile" pair at the last moment of approach, since the radar can only serve sequentially
live every such couple.

Immediately after launch, the rocket enters the radar coverage area within a few seconds using a software method, after which the data transmission line is turned on. The next time the radar beam passes through the angular direction in which the missile is located, it is captured for tracking. At the first stage of guidance, the missile is escorted "on the fly." In those moments when the radar beam

is aimed at the missiles, commands are transmitted to them guidance (control). Nine missiles can be aimed at the same time, three of them on the final part of the trajectory. In the described mode, the radar operates in the wavelength range of 6.1-6.7 cm. A control signal is sent to each missile defense system at its own carrier frequency to achieve electromagnetic compatibility of on-board control command devices. At the final section of the flight path, the missile defense system is carried out

there is a transition from the command guidance method to the self-guided mode

Radio relay communication equipment MRC-137

guidance with data relay from the missile to the ground to generate commands to control it. Illumination of the missile and target in this mode is provided by pulse-Doppler signals at a wavelength of 5.5-6.1 cm. The reflected signal is received by the missile and is sent via a transmission line to a ground-based radar for processing and generation of control commands. The radar operation cycle is 1 s, including 100 ms,

during the search, escort “on the way” and command guidance In the remaining time, the radar illuminates targets and missiles at the last stage of guidance through the missile, transferring beams from one missile-target pair to another. On the ground, the Patriot air defense

missile system division is located battery by battery. The batteries are located 30-40 km from each other for creating mutual overlap and dense fire at all heights. The launchers are located at a distance of up to 1 km from the fire control command post and radar, which is located in such a way that the antenna plane is directed toward the center of the air defense missile system’s sector of responsibility. An adjustment procedure is mandatory, which specifies the radar coordinates on the ground and the coordinates of the launcher relative to the radar. After this, the missiles in containers are installed in the required position in azimuth and elevation, and then transferred to remote control. The transfer time from traveling to combat position is about 30 minutes.

According to military experts, the strengths of the Patriot air defense system include multi-channel operation on target and missile, high noise immunity, survivability, degree of automation, sufficient mobility, ability to interact with other air defense systems. But the complex is inherent


Command post AN/MSQ-104 Power supply facilities

and disadvantages: the possibility of putting it out of action due to the destruction of the radar and interference with the missile defense guidance head and radio relay communication lines, the inability to track targets with radial speeds less than 30 m/s, a significant dependence of the choice of firing positions on the nature of the terrain. Since 1983, the United States

began a research and development program to modernize the Patriot air defense system within the framework of the PAK project (PAC - Patriot Antitactical Missile Capability) in order to give it the ability to hit tactical ballistic missiles. The main area of work was the creation of new radar and launcher software, as well as partial modernization of the missile defense system. In the first phase of the PAK-1 project, the radar operating algorithms were changed

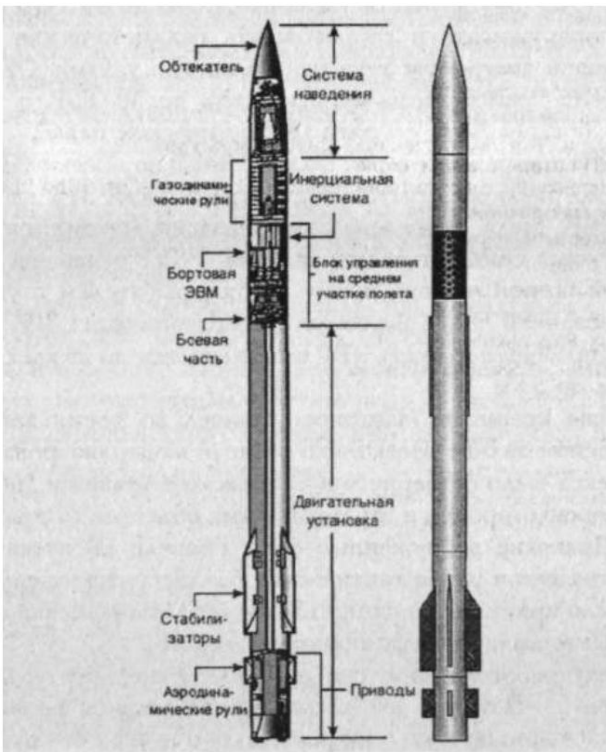
AN/MPQ-53 and missile guidance systems. As a result, the radar viewing angle in elevation increased from 45 to 90*, which made it possible to detect and track ballistic targets entering the beam pattern at large angles. The station acquired the ability to accompany up to 50 TBRs, and the complex - to fire at up to five ballistic targets.

In 1988, the second phase of R&D began on the PAK-2 project, which provided for expanding the capabilities of the air defense system to combat TBRs. The computer software of the control point computer was modernized, and the missile defense system was equipped with a more powerful warhead, a new radio fuse and an improved computer. As a result of modernization, the Patriot air defense system is capable of hitting TBRs at ranges of up to 20 km with a range of up to 5 km.

The Patriot's baptism of fire took place during the Gulf War. Several batteries of the modernized complex were deployed in Saudi Arabia and Israel to defend cities and strategic targets from Iraqi TBRs. The Iraqi armed forces conducted 83 launches of TBRs. When repelling an attack from tactical ballistic missiles, about 150 launches of modernized Patriot missiles were made, which hit 45 TBRs. A warning about the launch of Iraqi missiles was received by the Patriot complexes from the US Air Force Space Command, which received information about

the launches from the Imeyuz satellite strike warning system.

Satellite systems detected missiles at altitudes of 15-18 km after their launch. Data about the launch and approximate coordinates of the launch position were transmitted in real time through ground-based information processing centers to the command post of the Joint Central Command of the US Armed Forces in Saudi Arabia and further to the control points of the Patriot air defense system. The complex's radar detected ballistic missiles at ranges of up to 10 km. When the TBR was at a distance of 15-30 km from the air defense system and at an altitude of 30 km, the missile defense system was launched. The interception was carried out on the 15th-18th of the missile defense flight. Despite firing under almost ideal conditions (no false targets, radio interference, mass launch of TBR), the efficiency of the complex was low - about 0.5. When intercepting Iraqi TBRs, in most cases there was



Компоновочная схема ракеты ERINT

only defeating its hull, and not destroying the warhead with an explosive charge, which practically does not reduce the damage when firing at area targets. As a rule, the shelling of targets was carried out by two missiles.

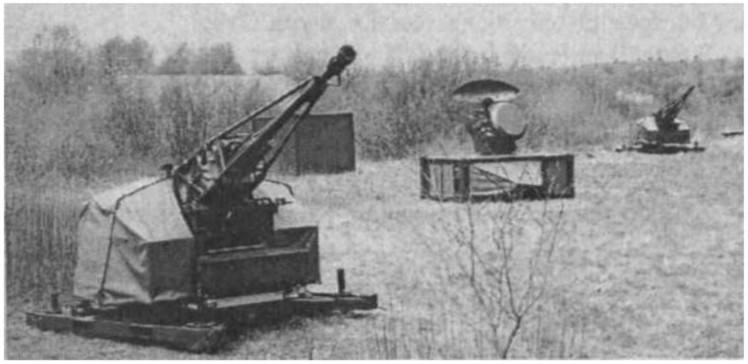
During the modernization of the air defense system under the PAK-3 program, a new, more effective ERINT missile defense system was created, and the radar was modernized and a control point, which increased the range of destruction ballistic missiles up to 40 km, and their interception altitude - up to 20 km.

The air defense system was supplied to Germany, the Netherlands, Italy, Japan nia, South Korea, Israel, Saudi Arabia.

TACTICAL AND TECHNICAL CHARACTERISTICS

Firing zone	circular
Damage range, km: maximum	
	100
minimum	3
Damage height, km:	
maximum	25
minimum	0.06
Number of missiles simultaneously aimed from the battery command post (including at the final section of the trajectory)	up to 8 (up to
Reaction time, s	3) 15
Launch intervals, s:	
from one	
launcher from	
different launchers	3 1
Missile length, m Missile	5.31
diameter, m Stabilizer span, m	0.41 0.87
Weight, kg:	
missiles	912
missiles in TPK	1696
warhead	91
Maximum rocket flight speed, m/s Maximum lateral	1700
overloads, g Flight time, s	up to
	30 8.3—17.0

"Skyguard/ Sparrow" (SWITZERLAND, USA)



The complex was created in the late 1970s by combining two systems: the Skygard fire control system, previously used to control the fire of the twin 35-mm towed Oerlikon anti-aircraft gun, and the Spar-row missile, a modification of the AIM-missiles. 7E, AIM-7F, AIM-7M class

"air-ground".

The basic missile of the Skygard air defense system is the AIM-7E missile, named RIM-7E-5. The Sea Sparrow sea-based air defense system uses the RIM-7H-5 missile. Much later, the US Navy began using the RIM-7M missile in this air defense system.

During combat operations, the Skygard/Spar Row complex surveys the space and identifies detected targets using a surveillance pulse-Doppler radar with a detection range of up to 20 km. The target is accompanied by either a tracking radar or an optical-electronic

module.

The launcher with 4 missile guides is mounted on the chassis of a twin towed anti-aircraft gun. The rocket's stabilizers deploy after it leaves the transport and launch container. Two pairs of missiles are located on the right and left sides of the operator’s workplace. Skygard fire control system over the past 20 years

went through several stages of modernization and, as part of various

These anti-aircraft systems are in service with the armies of Argentina, Austria, Canada, Egypt, the UAE and other countries. The Skyguard fire control system is designed to collect, process and analyze data about enemy airborne forces operating at low and extremely low altitudes, and to remotely control the firing of various fire weapons (anti-aircraft guns and missiles).

The system has high noise immunity due to the integrated use of many technical solutions, the main of which are a wide frequency tuning range of the air surveillance radar sounding signal, processing data from several detection equipment performing their functions in various environments.

regions of the electromagnetic spectrum, and compensation for passive interference. It is equipped with warning equipment for the launch of anti-radar missiles. The fire control algorithm embedded in it provides the possibility of optimal shelling of two or more anti-aircraft targets simultaneously.

new guns and missiles.

The Skygard system includes: an air target detection radar, a target tracking radar, an optical-electronic module and control panels for fire control system operators.

All equipment is placed in a unified cabin mounted on a two-axle towed trailer, armored

conveyor or other chassis.

Pulse-Doppler detection radar (frequency range 8.5-9.6 GHz) is used to survey airspace at ranges of up to 20 km, identify detected targets and track 20 of them, as well as issue target designation to tracking equipment (Radar or optical-electronic module) and fire damage. Frequency of sounding im-

pulses and their repetition period are set automatically depending on the interference situation. The polarization of the emitted signal is horizontal. The station antenna (rotation speed 60 rpm) is made in the form of a flat cylinder segment. The width of its radiation pattern is 1.3° in azimuth and 30° in elevation. The target tracking radar has a target acquisition range

for tracking up to 18 km and refers to monopulse stations. It provides tracking of targets with radial velocities close to zero, as well as direction finding of active jammers. It operates in the same frequency range as the detection radar, since it is connected to a common transmitter through a directional coupler. The width of the directional pattern is 2.4°, the use of 50-90% of the transmitter power to form the directional pattern of the tracking radar occurs automatically after locking on a target for tracking. The reflected signal received from the target is processed using equipment for stabilizing the level of false alarms,

passive interference compensation, etc.

The optical-electronic module consists of a television camera capable of operating around the clock, and a laser range measure that allows passive reconnaissance of air targets and tracking them in three coordinates (azimuth, elevation and range).

The fire control center consists of a digital computing complex based on the Ko-ra-PM processor, crew chief and operator consoles, and communication equipment. There is a built-in system for monitoring the technical condition of equipment, which allows timely detection of faults and elimination of them. Up to four fires are connected to one control point via radio or cable.

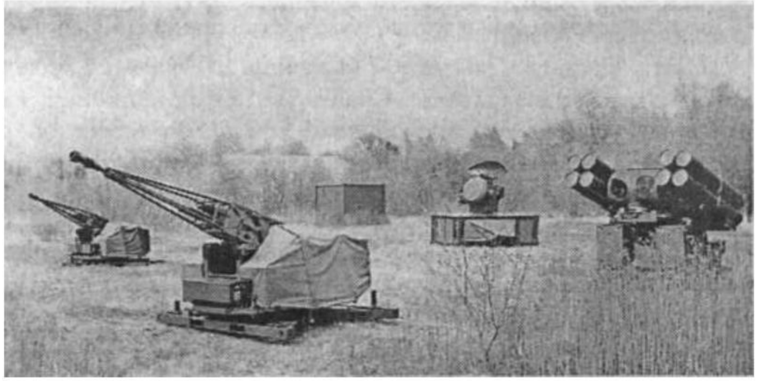
vykh funds.

High characteristics and the ability to interface the Skygard fire control system with various fire weapons contributed to the creation of modern anti-aircraft missile and artillery systems (ZRAK) on its basis at minimal cost and in a short time. The Swiss company Oerlikon-Contraves has developed two highly effective air defense systems - Skyguard-SAHV and Skyshield-ADATS. Work on the first complex was carried out jointly with the South African company Kentron since 1992. The Skygard-SAHV complex, in addition to the Skyguard fire control system, includes one or two launchers with SAHV-IR missiles (Surfase -to-Air Hight Velosity IR) and two 35-mm anti-aircraft auto-

tic guns. All elements in transport position are towed by army all-terrain vehicles.

The high-speed solid-fuel single-stage missile defense system SAHV-IR, produced in South Africa, is made according to a normal aerodynamic design and is equipped with a high-explosive fragmentation warhead, which is detonated by a laser fuse. The engine is equipped with fuel with reduced smoke generation and ensures the maximum range of missiles (8 km) is achieved in 14 s. The missile defense system has a relatively large total mass, which helps it maintain the achieved flight speed after the engine stops operating. It can be equipped with a weighted warhead, which ensures the most effective destruction of various types of targets. The missile is aimed at the target using a passive infrared homing head (GOS), created on the basis of the seeker of the South African Darter air-to-air missile. The target is captured by the seeker (viewing angle 100°) both when the missile is on the launcher (before launch) and during its flight. In the first case, shooting is carried out at air assets at a distance of no more than 3 km. To hit targets located

at a distance of 3-8 km, the second method is used, which is as follows. The missile defense system is launched at the interception point, determined according to tracking radar data, and



Anti-aircraft missile and artillery complex "Skyshield-ADATS"

Flight control until the head captures the target is carried out using an on-board inertial measurement unit based on the program entered into it before the start. When aiming the SAHV-IR missile defense system at a target, the proportional approach method and the "fire and forget" principle are implemented, which, under certain conditions, ensures the simultaneous interception of several enemy air targets.

The missile is located in a sealed transport and launch container weighing 45 kg, from which it is removed only for periodic maintenance and repair. The SAM launcher, which is mounted on the carriage of the Swiss GDF-005 cannon, carries eight missiles in the TPK. According to commands from the Skyguard fire control system, it automatically turns in the direction of the target to be destroyed. To cool the sensitive elements of the seeker, cylinders with liquid nitrogen are located on the launcher. The complex uses remote-controlled twin 35-mm GDF anti-aircraft guns from Oerlikon Contraves. They provide effective destruction of air targets at ranges up to 4000 m.

ZRAK "Skyshield-ADATS" is designed to destroy low-flying air and ground armored targets at ranges of up to 8 km at any time of the day. It includes the Skyshield fire control system, one or two launchers with anti-aircraft guided missiles and an optical-electronic module of the ADATS complex, as well as

two anti-aircraft guns.

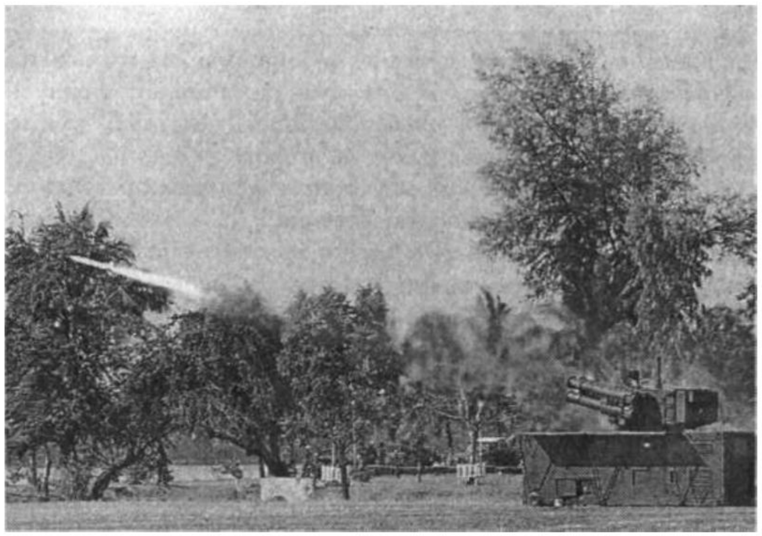
The Skyshield fire control system is a modernized version of the Skyguard. Its fundamental difference is that the radar and optical-electronic equipment is located separately from the control center, and this significantly increases the survivability of the ZRAK. For example, in the event of failure of the detection means of the fire control system, the search for targets can be carried out using optical-electronic modules available on each launcher.

The ADATS missile defense system is made according to a normal aerodynamic design. It is equipped with a solid propellant booster with two operating modes - starting and sustaining. In front of her

parts contain elements of a guidance system and a cumulative action warhead, detonated by a contact or non-contact fuse. In the tail section of the rocket there are four aerodynamic rudders (two have receivers for the laser guidance device). The launcher houses eight missiles in the TPK. Its guides can deviate in elevation within the range from -10° to +85° and in azimuth by 360°. An optical-electronic module is located between the launcher

guide assemblies . It includes a laser device for missile guidance, television and thermal imaging devices, as well as a laser rangefinder. Television and thermal imaging devices are designed for automatic detection and tracking of targets. Each has wide and narrow angles of view, respectively 3.8° and 0.9°, and *7.7°* and 3.0°. The laser rangefinder is used to determine the range to the target and ensure the optimal moment to detonate the warhead of the missile defense system. The module allows you to track targets at an elevation angle from -1° to +90° at any azimuth. 35-mm anti-aircraft automatic gun, the operation of which

based on the principle of gas removal, has a rate of fire



Rocket launch using the Skyshield-ADATS complex

1000 rounds/min, firing range against aircraft up to 4 km and cruise missiles up to 3 km. It is equipped with a high-speed computer interfaced with the Skyshield control system. A special unit for measuring the initial velocity of the projectile and fuse arming is installed at the muzzle of the gun barrel. The use of the new AHEAD (Advanced Hit Efficiency And Destruction) anti-aircraft projectile significantly increases the effectiveness of hitting air targets. It consists of a thin-walled body filled with 152 cubic tungsten elements weighing 3.3 g each, an expulsion charge and a remotely programmable explosion.

vatela.

The new Skyshield-ADATS air defense missile system has a short reaction time (4.5 s), as well as high fire capabilities and a degree of automation of combat work processes. It can be transported over long distances using aircraft

and helicopters.

In 1984-1987 18 batteries of the Skygard/Sparrow air defense system were delivered to Egypt, which received its own name “Amoun”. The battery includes one Skygard fire control system, two twin 35-mm towed GDF-003 anti-aircraft guns, two Sparrow launchers with 4 missiles each. The Amoun complex can fire and destroy up to three targets simultaneously: two with missiles, and one with

cannons. The reaction time is 4.5 s for anti-aircraft guns, and 8 s for Sparrow missiles.

The systems supplied to Egypt have been modernized in 16 areas, including a new RAS antenna with reduced influence of interfering reflections from the underlying surface of the earth, a new computer and software. The equipment of the workplaces of three operators was modernized. The radar target detection range has been increased to 20

km, and the optical range to 15 km. In Egypt itself, it was planned to organize the production of individual components of the system. In Greece, the Skygard air defense system was named

The Velos missile uses the RIM-7M missile.

In Spain, the Skygard fire control system is combined with the Spada launcher, which houses

Xia Aspid missiles. The assembly of the Spanish version of the complex, called “Toledo,” was carried out on the territory of Spain, where the transport and launch container for the missile, and individual electronic and mechanical units for the launcher were also produced.

In 1980, demonstration live firing of the Sky Guard/Sparrow complex took place at the NATO NAMFI training ground, located on the island of Crete. The target used was a radio-controlled unmanned target “Chukar”, which had a cruising flight speed. The target flew up to the firing position of the Skygard/Sparrow complex with a parameter of 700 m and had a speed of more than 200 m/s. The first missile hit the target at a distance of more than 12 km by directly hitting the target. The second shooting at a new target was carried out by detonating the warhead with a proximity fuse, the miss was 1 m. The target was destroyed. In mid-1991, successful live firing took place with the AIM-7F missile; a direct hit was made on a radio-controlled target with a speed of more than 200 m/s at a distance of

over 10 km.

Later, successful control live firing took place at a radio-controlled target that had supersonic flight speed, and the firing was carried out in poor conditions.

visibility and strong winds.

TACTICAL AND TECHNICAL CHARACTERISTICS OF MISSILES

	AIM-7F	SAHV-IR	ADATS
Damage range, km:			
maximum	13—20	8.0	10.0
minimum	1.5		
Damage height, km;			
maximum	5.0	-	7.0
minimum	0.015		
Rocket length, m	3.66	3.36	2.05
Body diameter, m Wing	0.20	0.18	0.15
span, m Weight, kg:	1.02	0.4	0.36
missile	233.6	133.0	51.4
warhead	39.0	20.0	12.0
Maximum missile speed, m/s	700	1050	1000

RBS-23 BAMSE

(SWEDEN)

The RBS-23 BAMSE complex is designed to engage air targets at ranges of up to 15 km, at altitudes from several tens to 12,000 meters. It should take a middle position between the small and large air defense systems

range.

Development of the complex began in 1993. RBS-23 BAMSE MSAM (Medium Surfase-to-Air Missile System - medium-range complex) is intended for the Swedish armed forces and was created jointly by Bofors AB and Ericsson Microwave System AB. Missile and guidance cabin MFU (Missile

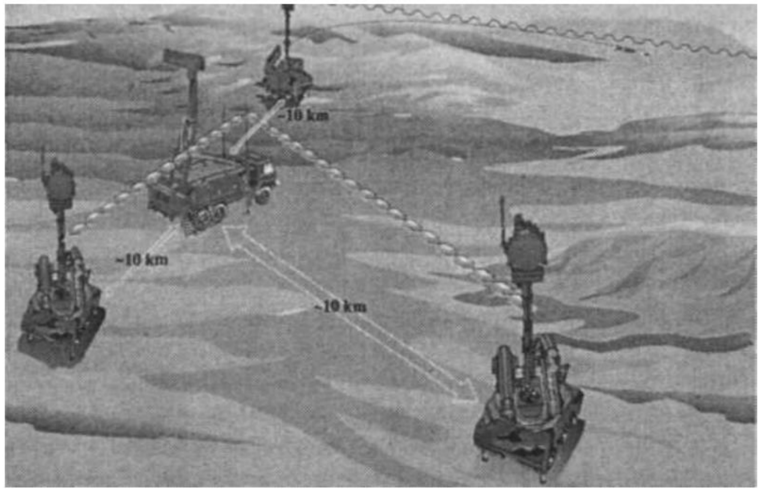
Fire Unit) was developed by Bofors. Ericsson Microwave System AB has developed a new generation Giraffe 3-D surveillance radar and guidance radar, as well as a combat control cabin (Command, Control, Communications, Intelligence), which has armor protection and a protection system against the damaging factors of nuclear weapons.

The first prototype of the RBS-23 BAMSE complex was created in 1998, serial production was planned to begin in 2000. According to its performance characteristics, it is capable of covering a significantly larger area, and this determines its use for air defense cover of air bases, naval ports and the destruction of air targets before they can use conventional bombs. If missile weapons are used, then the complex is capable of detecting and destroying targets with a small effective dispersion surface.

Experts believe that two or three battalions equipped with the RBS-23 BAMSE complex are sufficient for Sweden. And yes-

Export orders are expected to be fulfilled.

Taking into account the fact that the complex itself has high mobility and short coagulation (deployment) time,



Order of battle for the RBS-23 air defense system

it can be used for air defense cover for mobile army units.

The RBS-23 BAMSE battery includes a battery control center (CCC - Combat Control Center) and two to four MCLV (Missile Control and Launct Venicles) chassis with launchers. The surveillance radar and battery command post are located on the same chassis. The radar antenna extends
to a 12-m height using a mast device, which allows the chassis to be placed in shelter, terrain folds, etc. The radar uses digital signal processing, which increases

accuracy of tracking and determination of target coordinates.
In addition, the completeness and volume of information about the air situation allows the MCLV chassis to control the fire weapons of other air defense systems.

The MCLV chassis communicates with the battery command center via cable or radio link. For stable information exchange, the Swedish Army uses communications equipment that meets the TS9000 standard, thereby achieving the required noise immunity and exchange speed. The distance of the battery command post from the chassis may vary, but is usually 10 km. Thus, if the battery contains four chassis with launchers, then the distance between them can reach up to 20 km.

The MCLV all-terrain chassis has all the necessary means to destroy an air target. It houses rechargeable missile containers. The chassis reloading time is several minutes. On the mast device of the MCLV chassis, a guidance radar antenna, a thermal imager (TIS - Thermal Imaging System) and friend-or-foe identification equipment are raised. The missile is guided in flight along the line of sight using a guidance radar, which is a modernized version of the Ericsson Eagle Low Probability of Intercept (LPI) radar. It guides up to two missiles to each target.

The radar is capable of detecting and tracking targets against the background of the underlying surface (ground), which allows the complex to fire at low-altitude targets. On the launcher

The installation contains four missiles stored in transport but launch containers. The rockets launch at a certain angle. The rocket is high-speed, the maximum
speed reaches M3.0. The warhead is fragmentation, contact type fuse. The transport and launch container has a cylindrical shape. The missile is capable of destroying all types of air targets and remotely controlled aircraft - from low-speed targets with a large scattering surface (transport aircraft) to high-speed

rockets.
The RBS-23 BAMSE complex has built-in equipment control, training and recording equipment, the last two allow for training of combat crews, completely simulating combat operations, excluding

real rocket launches.
The RBS-23 BAMSE complex is air transportable using the C-130 Hercules transport aircraft located on
weapons of the Swedish Air Force.

Application

US frequency band conventions

A -	0-25 0 MHz
IN -	250-500 MHz
C -	500 MHz - 1 GHz
D -	1 - 2 GHz
E -	2 - 3 GHz
F-	3 - 4 GHz
G-	4 - 6 GHz
N -	b - 8 GHz
I -	8 - 10 GHz
J -	10 - 20 GHz
K -	20 - 40 GHz
L-	40-6 0 GHz
M -	60-100 GHz

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